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The Engineer

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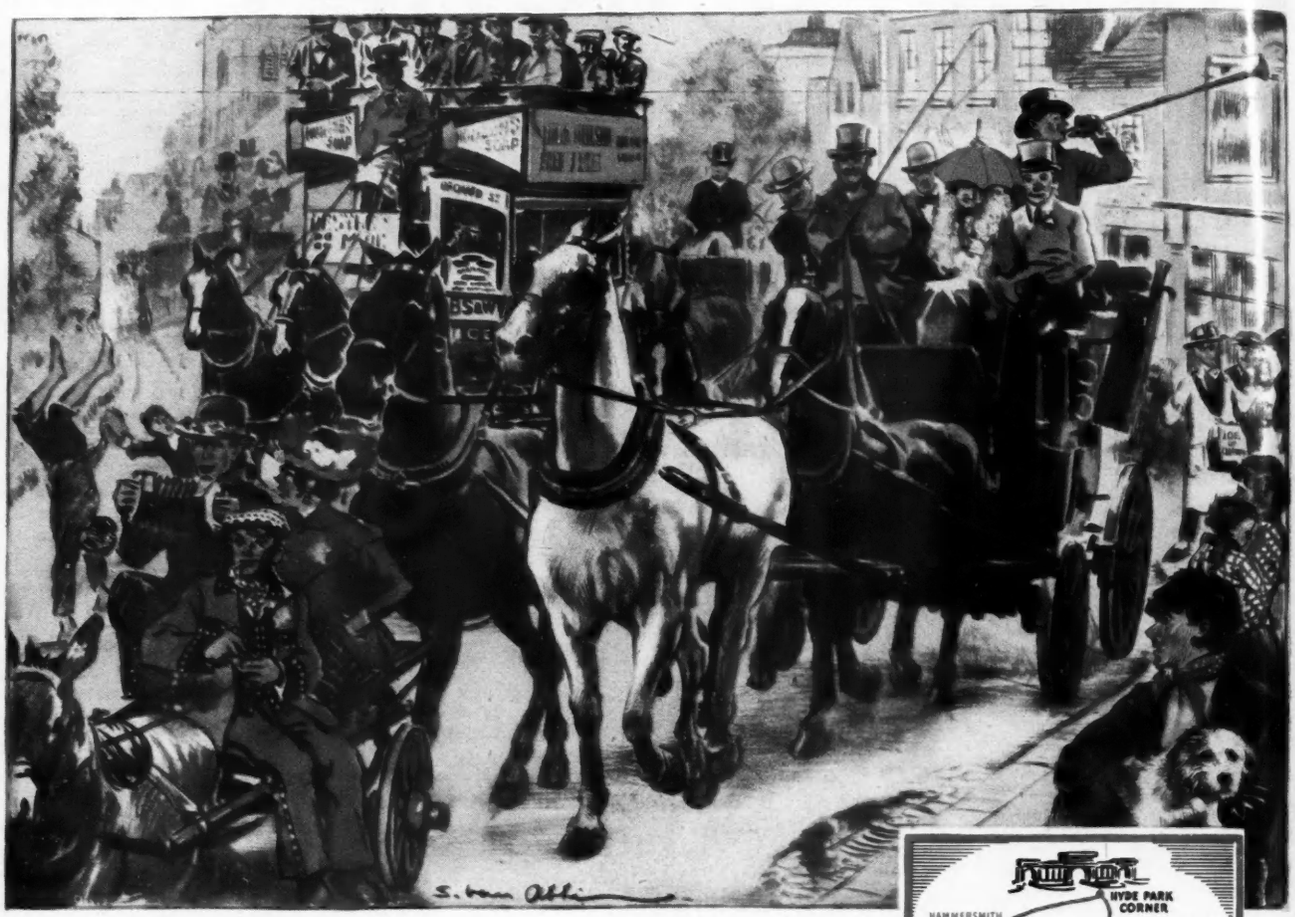

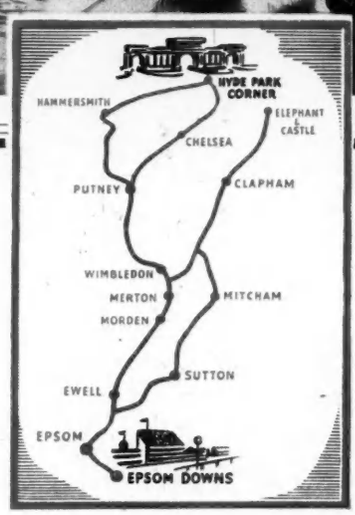

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Barely twenty miles in length, the Epsom Road for at least one day a year enjoys World fame.

On that day—Derby Day—it becomes Britain's busiest road leading to Epsom Downs, the venue of the World's greatest horse race—the Derby. Founded in 1870 by the 12th Earl of Derby, the spirit of the event remains unchanged, but materially it has altered beyond recognition.

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The Engineer

LONDON, FRIDAY, DECEMBER 17, 1943.

PUBLIC NOTICES

MINISTRY OF LABOUR AND NATIONAL SERVICE

ASSISTANT INSPECTORS

Applications are Invited from suitably qualified candidates for the following posts (London and Provinces) in a Government department :—

ASSISTANT INSPECTORS I and II (covering Groups A and B).

Salary : Grade I, £550 to £700 ; Grade II, £350 to £550, both according to qualifications and experience.

GROUP A POSTS.

The duties of the various posts cover the inspection of Inspection and Testing of Complete Armoured Fighting Vehicles, Assemblies and Component Parts, Investigation of Manufacturing Defects, and Initiation of Action to Prevent Recurrence.

Sound technical and practical training and experience in Mechanical Engineering is required, preferably in Heavy or Marine Engineering or in Modern Engineering Production Methods. Knowledge of Internal Combustion Engines is desirable, and experience of Inspection Work in a large organisation is preferred.

GROUP B POSTS.

The duties of the various posts cover the inspection of Ferrous and Non-Ferrous Metals used in the Manufacture of Armoured Fighting Vehicles and Dimensional and Functional Inspection of Component Parts.

Sound technical and practical training and experience in Mechanical Engineering is required, with special knowledge of Foundry Practice, the Nut and Bolt Industry, the Metallurgy of Ferrous and Non-Ferrous Metals, or the Armour Plate Industry. Experience of Inspection Work in a large organisation is desirable in all cases.

Applicants should write to the MINISTRY OF LABOUR AND NATIONAL SERVICE, CENTRAL (TECHNICAL AND SCIENTIFIC) REGISTER, ADVERTISING SECTION, ALEXANDRA HOUSE, KINGSWAY, LONDON, W.C.2, for the necessary forms. The reference number C. 1952A must be quoted, and also the grade and group for which the application is being made should be stated. 8693

MINISTRY OF LABOUR AND NATIONAL SERVICE

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METAL SHOPS SUPERINTENDENT
ASSISTANT CHIEF OF PRODUCTION CONTROL

Required by Large Company in South, Manufacturing Wood and Metal components :—

(1) WORKS ENGINEER (Order No. 275), with good experience in Plant Maintenance (including Electrical) and Lay-outs of New Projects required. Salary, £700 to £850 p.a.

(2) METAL SHOPS SUPERINTENDENT (Order No. 262). Machine Shop experience essential, and Coppersmith experience desirable. Salary, £750 to £850 p.a.

(3) ASSISTANT CHIEF of PRODUCTION CONTROL (Order No. 274). Must be thoroughly conversant with Engineering Procedure and Operation of Works Documents, with good administrative ability and experience in dealing with large staff. Salary, £500 to £600 p.a.

Salaries will be fixed, within each range, according to qualifications and experience. Good post-war prospects.

Applicants must be over 30 years of age at date of registration under N.S. Acts or not liable to military service.

Applications, in writing (no interviews), stating date of birth, full details of qualifications and experience (including list in chronological order of posts held and salaries earned), and quoting the appropriate Order No., should be addressed to the MINISTRY OF LABOUR AND NATIONAL SERVICE, A.O., 16, WESTWOOD ROAD, SOUTHAMPTON. 8694

OVERSEAS EMPLOYMENT

ASSISTANT ENGINEERS (CIVIL)

Overseas Employment.—ASSISTANT ENGINEERS (CIVIL) REQUIRED for the Government Railways in West Africa for the duration of the emergency or one tour of 12 to 24 months, whichever is the lesser period in the first instance, with prospect of permanency. Salary £475, rising to £840. Commencing salary according to qualifications and experience. Separation allowance for married men is £80 on salary of £475. Free quarters, passages, and medical attention. Candidates must be Associate Members of the Institution of Civil Engineers or hold a degree or diploma exempting them from Sections A and B of the A.M.I.C.E. examination and have had practical experience of Railway Civil Engineering Work.

Applicants should write to the MINISTRY OF LABOUR AND NATIONAL SERVICE, CENTRAL (TECHNICAL AND SCIENTIFIC) REGISTER, ADVERTISING SECTION, ALEXANDRA HOUSE, KINGSWAY, LONDON, W.C.2, for the necessary forms. The reference number E. 778A must be quoted. 8696

The Engineer

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

CRANE WORKS REQUIRE MANAGER to Take Control of Production. Only fully qualified man with Works Management experience will be considered.—Applications to be made in writing to JOSEPH BOOTH and BROS., Union Crane Works, Rodley, Leeds. Envelopes to be endorsed "Application for Manager." 8708 A

ESTIMATOR REQUIRED by Large Concern of Electrical Manufacturers. Applicants should be exempt from military service and have previous experience in Modern Estimating Methods, Time and Motion Study, and Budgetary Control. —Address fully, in confidence, stating age, previous experience, and salary required, 8718, The Engineer Office. 8718 A

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS
1941 No. 2069
RESTRICTION ON ENGAGEMENT ORDER

DEPARTMENTAL MANAGER REQUIRED for Heat Treatment Department, Steel Works, North Midlands ; must have had previous experience and technical education, capable and organising ability, and experienced in Labour Control (this is important). Permanent position. Salary £800 per annum. State age and experience chronologically.—Address, P6511, The Engineer Office. P6511 A

FIRST-CLASS DESIGNER WANTED for work in connection with Light Mechanical Equipment. Inventive ability and some practical skill essential. Work would be carried out in conjunction with team of experts in other fields. Good position for experienced technician with initiative and hard-working ability. Give full particulars.—Address, 8714, The Engineer Office. 8714 A

PUBLIC NOTICES

OVERSEAS EMPLOYMENT
GOVERNMENT OF INDIA

FOREMEN AND ASSISTANT FOREMAN

Urgent Vacancies as Below exist in the Indian Ordnance Department for the duration of the war. Pay and war allowance approximate to £598 per annum for Foreman and £504 per annum for Assistant Foreman, plus overtime ; bonus of six months' pay on satisfactory termination of service ; free furnished quarters (including free electricity and water) ; free medical attention ; free passage to and from India ; education allowance for children. Age not exceeding 50 years.

FOREMAN (Instrument Fitting and Assembly), Mathematical Instrument Office. Full apprenticeship with firm engaged in the manufacture of Scientific Instruments. At least 7 years' experience in all branches of Instrument Fitting and Assembly.

FOREMAN (Millwright), Machine Shop. Thorough practical training and at least 7 years experience in Millwright Machine Shop and Fitting Work. Capable of taking charge of millwright work in a shop containing approximately 300 machines and charge of fitters on work ranging from Ship Engines and Auxiliary Plant, Cranes and Hoists to Railway Maintenance Parts, &c.

ASSISTANT FOREMAN (Gun Machinist). Experience in Ordnance Manufacture (6-pdr., 3.7in.).

Written applications (no interviews), stating age, family, if any (married applicants should also state if prepared to travel alone), name of present employers, and full details of apprenticeship and experience, should be made in writing not later than 29th December, 1943, to the SECRETARY, OVERSEAS MANPOWER COMMITTEE (Ref. 160), MINISTRY OF LABOUR AND NATIONAL SERVICE, ALEXANDRA HOUSE, KINGSWAY, LONDON, W.C.2. 8697

SITUATIONS OPEN

MANAGER for IRONFOUNDRY in West Riding. Must have up-to-date experience of Foundry Practice, Floor Moulding, Plate Moulding, Green and Dry Sand. Approx. output 120 tons per week. Salary £650.

Applications in writing (no interviews), stating date of birth, full details of qualifications and experience (including list in chronological order of posts held), and quoting Order No. 559, should be addressed to the MINISTRY OF LABOUR AND NATIONAL SERVICE, Appointments Office, Britannia House, Broadway, Bradford. 8695 A

MANAGER, Engineering, REQUIRED, to Take Charge of Technical and Production Control. Permanent post on work of national importance ; excellent assured post-war situation. Requirements : Good General and Technical Education, Tool Room and Staff Control experience. Applications, which are confidential, must include full details of qualifications, age, positions held, salaries received.—Address, 8646, The Engineer Office. 8646 A

REINFORCEMENT MANUFACTURERS, with works in London area, REQUIRE ASSISTANT MANAGER with experience of Mild Steel Bar and High-Tensile Steel Mesh for Reinforced Concrete. Applicants should have knowledge of Designing and Estimating. The post is permanent and progressive. Replies will be treated in strict confidence and should give age, details of experience, and salary required.—Address, 8702, The Engineer Office. 8702 A

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The Engineer

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The Charges for Classified Advertisements are 1/6 per line up to one inch—minimum charge, 6/-; those occupying one inch or more at the rate of 19/- per inch. Box numbers, 1/- extra, except in the case of advertisements under "Situations Wanted." Orders MUST be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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"Engineer Newspaper, Estrand, London."
Tel., Central 6565 (10 lines).

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Also thorough knowledge of General Lathe, Planing, and Milling Machines.

Should also be capable of Supervising and Developing Small Tool Room.

This position has post-war prospects and would be a permanency for the right man.

Address, stating age, full particulars of experience, and salary required, 8717, The Engineer Office. 8717 A

REQUIRED by Large Metallurgical Works, an INDUSTRIAL MECHANICAL or CHEMICAL ENGINEER with first-class experience of Works Management and Handling of Labour. Time and Motion Study experience an advantage, but not essential. Good general and technical education, preferably university standard. Age 30 to 45. Position permanent and of important executive nature. Work of highest national importance, taking high priority, and there are good prospects of advancement. Commencing salary £700 to £800 p.a., depending on qualifications.—Address, 8691, The Engineer Office. 8691 A

SCIAKY ELECTRIC WELDING MACHINES, Ltd., Slough, Makers of High-Grade Resistance Welding Machines, invite APPLICATIONS for REPRESENTATIVE for the Midland Counties. Must have experience of Resistance Welding Machines and their application. Sound post-war prospects.—Write, full particulars, experience, remuneration, &c. 8715 A

SUPERVISOR REQUIRED by Large Motor Vehicle Manufacturing Organisation, to Control Training Scheme for Engineering Pupils and Apprentices. Approved applicant will require to possess a sound educational and engineering background and also good organising ability; he must also thoroughly understand youth psychology and be capable of inculcating discipline by virtue of self-capacity for leadership.—Address, 8692, The Engineer Office. 8692 A

THE Post You Are Seeking May Not Be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

SITUATIONS WANTED

A. M.I.E.E. (30), At Present Acting as a Technical Adviser (Admiralty), DESIRES to CONTACT CONTRACTORS who will be engaged on post-war reconstruction at home or overseas. Experienced in E.H.T. and L.T. transmission and distribution, power installations, and electro-mechanical devices.—Address, P6520, The Engineer Office. P6520 B

AUTOMOBILE ENGINEER (29), D.L.C. (Hons.), G.I.A.E., with experience in design and testing of I.C. and C.I. engines and familiar with modern production methods, SEEKS IMMEDIATE EMPLOYMENT in Automobile or Aircraft Industry.—Address, P6530, The Engineer Office. P6530 B

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ENGINEER REQUIRES EXECUTIVE POSITION, preferably works or assistant works manager. Twenty years' engineering experience, press tools, jigs, and fixtures, latest methods mass production. Free.—Address, P6527, The Engineer Office. P6527 B

SITUATIONS WANTED

ENGINEER (39), A.M.I.P.E., DESIRES POS. as Production Manager or similar post. Twenty years' experience in mass production, tool design, and control; at present disengaged; keen, energetic, and tactful disciplinarian.—Address, P6528, The Engineer Office. P6528 B

ENGINEER (39), A.M.I. Mech. E., A.M.I. Prod. E., A.I. Indust. Admin., DESIRES CHANGE as Production Manager or similar post. Twenty years' experience in mass production, tool design, and control; at present holds executive position; keen, energetic, and tactful disciplinarian.—Address, P6485, The Engineer Office. P6485 B

FUEL ENGINEER and CHEMIST (37), Degree, A.M.I. Gas E., SEEKS POST as Boiler Plant Superintendent or equivalent. Wide experience, first-class refs. Release obtainable.—Address, P6521, The Engineer Office. P6521 B

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers 1s. extra, which includes despatch of all replies.

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IT is DESIRED to SECURE the FULL COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENT No. 525,215, which relates to "Method of an Apparatus for Straightening Bars, Rounds, and the like," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the Patentee.—Interested parties desiring copies of the patent specification should apply to STEVENS, LANGNER, PARRY and ROLLINSON, 5 to 9, Quality Court, London, W.C.2. 8700 H

THE PROPRIETORS of BRITISH PATENTS Nos. 292,494, 351,079, 353,525, 354,707, 383,531, 383,532, 406,510, 414,221, 465,745, 474,275, 472,018, 442,211, 445,901, 445,910, and 489,578 are prepared to LICENSE British Manufacturers to WORK thereunder. They relate to "Rolling Mills and Methods and Apparatus for the Rolling and Coiling of Metal Strips, Bands, and Sheets."—Address, BOULT, WADE and TENNANT, 112, Hatton Garden, London, E.C.1. 8698 H

THE PROPRIETOR of BRITISH PATENTS Nos. 528,316 and 529,452, both for "Improvements in Universal Joints," DESIRES to ENTER into NEGOTIATIONS with a firm or firms for the SALE of the PATENTS or for the GRANT of LICENCES thereunder.—Further particulars may be obtained from MARKS and CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.2. 8701 H

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For continuation of Small Advertisements see page 50

A Seven-Day Journal

"Motorways for Britain"

ON Thursday, December 9th, there was opened at 22, Lower Regent Street, London, a "Motorways for Britain" Exhibition, arranged by the British Road Federation. The Exhibition is of a type which appears to be increasing in popularity. It consists of a number of panels holding photographs and/or diagrams with short explanatory wording, together with working models of motorways and a "clover-leaf" crossing, the whole designed in particular to appeal to the general rather than the technical public. The Exhibition is intended to show that motorways would stimulate trade, reduce costs by lowering transport expenses, relieve congestion on local and other roads, prevent accidents, &c. At a luncheon that followed the opening of the Exhibition, Mr. G. N. Wilson, Chairman of the Federation, said he had seen it suggested in a recent speech that the case for motorways must rest on a survey of needs. It was wrong to suggest that that survey was something still to be carried out. It was made, he contended, by the County Surveyors' Society and by other learned bodies, and these had resulted in a virtually unanimous recommendation that at any rate a limited system of motorways be constructed. Sir William Rootes, who had opened the Exhibition, called upon the Government at the appropriate moment to announce a bold policy in regard to the development of roads. He said that few appreciated the handicaps which had been imposed upon the country through lack of road development, and hoped that the work would be considered of such vital concern that it would be lifted out of the sphere of party politics.

The Late Mr. John George Robinson

THE death of Mr. John George Robinson, which occurred at the advanced age of eighty-seven, on December 7th, will be widely regretted in railway circles. He was, it will be recalled, the chief mechanical engineer of the Great Central Railway Company from 1902 until 1923. He came of a railway family, and his father, the late Matthew Robinson, was the divisional locomotive, carriage, and wagon superintendent of the Great Western Railway. He was educated at Chester and served his apprenticeship at the Great Western works at Swindon. Later he gained railway experience in Ireland, where he was the locomotive, carriage, and wagon superintendent of the Waterford, Limerick, and Western Railway. In July, 1900, Mr. Robinson was appointed locomotive superintendent of the Great Central Railway. In 1902 he took charge of the carriage and wagon department and was made chief mechanical engineer. He designed several new classes of locomotives for Great Central service, most of which we described in THE ENGINEER. An early engine was the single-driver express locomotive with a Belpaire firebox. His six-coupled express engine and the three-cylinder compound engine with bogie and tender attracted the attention of the late Charles Rous-Marten, who will be remembered as a popular writer on railway runs. Rous-Marten's articles on "Great Central Compound Engines and their Work" appeared in our issues of April 24th and May 1st, 1908. Other locomotives designed by Mr. Robinson, which we described and illustrated, included the six-coupled express engine "Sir Sam Fay," the express 4–6–0 goods engine "Glenalmond," and the six-coupled large tank engine with Robinson superheater. The four-cylinder express passenger engine "Lord Faringdon" was another noteworthy superheater locomotive, while one of the last Robinson engines was the four-coupled superheater passenger engine of 1922. In 1919 and 1920 Mr. Robinson conducted some important experiments on the uses of pulverised and colloidal fuels in locomotive boilers. He laid out the company's new carriage and wagon works at Dukinfield, and was responsible for enlarging and modernising the locomotive works at Gorton. He was concerned with the special three-cylinder high-pressure eight-coupled tank shunting locomotives, the first of their kind, which were built for pushing loaded trains over the humps at the shunting and marshalling yards at Wath, near Doncaster. During the last war Mr. Robinson was a member of the Railway War Manufacturers' Sub-Committee, and, in addition to supervising war production at the company's works, he designed a 2–8–0 tender engine with a Robinson superheater for service in France. His superheater design gained for him a Diploma for Grand Prix at the Latin-British Exhibition, and he also designed a successful lubricator for locomotive and marine engine use. His services to the nation were recognised when he was awarded the C.B.E., and for many years Mr. Robinson was a well-known member of the Institution of Civil Engineers and the Institution of Mechanical Engineers.

The War Against U-Boats

THE official statement issued last week under the authority of Mr. Churchill and President Roosevelt revealed that German submarines during November sunk fewer merchant ships than in any month since May, 1940. Thanks to the protection of convoys by aircraft operating from the Azores, for the fourth successive month more U-boats were sent to the bottom than merchant ships sunk. The statement is as follows:—"Anti-U-boat operations in November have been notable for the little the enemy has achieved for the great effort he has exerted. The number of merchant vessels sunk by U-boats in November is less than in any other month since May, 1940. By means of aircraft operating from the Azores, we have been able to improve the protection to our convoys and to diminish the area in which enemy U-boats were free from attack by our forces. The enemy has used long-range aircraft to assist in concentrating U-boats on our convoy routes. In spite of this, our escort and counter-attacks have been effective. The caution of enemy U-boats has lessened the number of opportunities given to our forces for strikes at them. Nevertheless, the number of U-boats sunk in November has again exceeded the number of their victims." It will be recalled that last month it was disclosed that during the previous six months more than 150 U-boats had been destroyed, and that during August, September, and October more enemy submarines were sent to the bottom than Allied merchant ships were sunk by U-boat action. Tonnage losses in October from all causes were reported to be the second lowest of any month of the war.

The British Coal Utilisation Research Association

SPEAKING at the annual meeting of the British Coal Utilisation Research Association, which took place in London on Wednesday, December 15th, Sir Evan Williams, the President of the Mining Association of Great Britain and the British Coal Utilisation Research Association, in his address, spoke of coal research as being the largest of the co-operative industrial research enterprises in this country. The money, he said, was forthcoming for research work, and the British colliery owners, through the Mining Association, had increased their financial grant this year by 50 per cent. In order to develop coal fully, not only for both heat and power for home and industry, but also for liquid fuel and materials for the chemical industry, the coal industry had undertaken the responsibility for hydro-carbon research, and for this particular purpose the colliery owners are to contibute a fund of the order of £400,000 to £500,000 over the next two or three years. The Research Association is to develop synthesis processes for making hydro-carbon oils from coal, which are reported to be more efficient than the German Fischer-Tropsch process, and is to assist in providing the chemical and associated industries with raw materials produced from our indigenous resources. The Mineworkers' Federation has now accepted an invitation to appoint two members to the Council of the B.C.U.R.A., and Mr. S. Watson and Mr. G. H. Jones have been nominated. Sir Evan also referred to the new domestic fire evolved by the Research Association, which not only did away with smoke, but had an efficiency about double that of the old-fashioned fire. With regard to future progress, Sir Evan pointed out that an outstanding difficulty was that of translating the results of research work into actual practice. The Association, he said, after carefully considering this problem, had decided that it must undertake to establish the commercial value of new scientific and technical discoveries by the trial manufacture of new appliances and the pilot plant operation of new processes. For this purpose the new site of a coal research station at Leatherhead would be used, and on completion it is expected to be the finest of its kind in the world. A new beginning has been made during the year by organising joint conferences at which important problems can be discussed with other scientific workers and with representatives of the coal-consuming interests.

New Cammell Laird Appointments

LAST week it was announced by Cammell Laird and Co., Ltd., of Birkenhead, that Sir Robert Johnson, the chairman and managing director of the company, has appointed Mr. H. R. Humphreys as assistant to him, with the title of assistant to the managing director. Mr. Humphreys has also been elected to a seat on the board. He served his apprenticeship with the firm from 1910 to 1915, and has spent the whole of his time with the firm except for a period of temporary service during the last war when he served as an engineer officer in the Royal Navy. For the last twelve years Mr. Humphreys has held the post of repair works manager, and two years ago he was made a local director of the company. He has been succeeded by Mr. D. Skae, who has also spent the whole of his professional career with Cammell Laird, and who has acted as assistant repair manager during the last nine years. It is also announced that Mr. J. P. Anderson, who is the assistant to Mr. W. H. McMenemy, the engineering manager and director of the company, has now been appointed a local director of the firm. Mr. Anderson has been with the firm for twenty-one years. His apprenticeship was served with the Wallsend Slipway and Engineering Company, Ltd., at Wallsend-on-Tyne, after which he joined William Denny and Brothers, Ltd., at Dumbarton, and was later with Scotts' Shipbuilding and Engineering Company, Ltd., at Greenock, before going to take up his appointment with Cammell Laird and Co., Ltd., at Birkenhead.

The Late Baron Graevenitz

WE regret to learn from Siemens-Schuckert (Great Britain), Ltd., of the death, on Wednesday, December 8th, at 50, Hans Crescent, of Baron Peter Graevenitz, who had been a director of the company since 1935. Baron Graevenitz was a Russian by birth and was educated and trained in Russia, and held the rank of Lieutenant-Colonel in the Imperial Russian Army. He entered the Russian Diplomatic Service and at one time he was accredited to the Court of St. James's. On his mother's side he was a member of the Siemens family and a nephew of the late Carl Friedrich von Siemens. After the last war Baron Graevenitz settled in this country and became a British subject. He was associated in an administrative capacity with the building of the Shannon power scheme in Ireland, and on the completion of that scheme he joined the firm of Siemens-Schuckert (Great Britain), Ltd., was elected to the board in 1935, and served on it until his death. Baron Graevenitz took a keen interest in the Electrical Industries Benevolent Association, of which he was a Governor. He was Secretary of the West Middlesex Branch of the Association, in the formation of which he took an active part. He was well known, and his death after a painful illness, which was borne with great courage, will be deeply mourned by many friends.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XXIV—(*Continued from page 464, December 10th*)

THE PRINCIPAL HARBOURS OF SOUTHERN AFRICA

THERE were no natural harbours in the Union. All those now in use had to be wrested from Nature. Before harbour works were undertaken, vessels lying at anchor off the coast felt the terrible effect of gales. Many a gallant East Indiaman lies "docked in the sand" in Table Bay, where, it is said, some 300 ships have been wrecked since the first Dutch settlement; thousands of lives, and goods valued at £20,000,000, have been lost.

In 1858 the Government of the Cape of Good Hope appointed Mr. (later Sir John) Coode, of Westminster, to be engineer-in-chief for the harbour to be constructed in Table Bay. The original design comprised a breakwater 3250ft. in length, with inner and outer basins having areas of 10½ and 4 acres respectively. The rapidly developing trade of the port rendered further increase of accommodation desirable. Sir John Coode in 1883 designed a closed outer harbour under the lee of the breakwater, which was considerably extended.

In 1937 a new scheme, the initial stages of which cost nearly £3¾ million, was begun. The total cost of a big graving dock was estimated at about £2 million. The dock will be large enough to accommodate the "Queen Elizabeth." A great deal of digging and blasting of solid rock will be needed to obtain the required depth of 45ft. for the dock, which will only need a veneer of concrete, averaging about 2ft. in thickness on the floor. The scheme includes a new basin to cover 300 acres, and will reclaim a land area of 363 acres. The dimensions of the dock will be not less than 1000ft. long and 150ft. wide. A floating crane, capable of lifting 60 tons at a radius of 80ft. and 20 tons at a radius of 90ft., is to be provided.

Durban deals with a greater volume of commerce than any of the other ports, Cape Town being next on the list. The capital expenditure on harbour improvements at Durban (Port Natal) exceeds £6½ million, which is roughly £2 million above the total for harbours at the time of the union in 1910. Additional improvements, to cost nearly another £2¼ million, were undertaken in 1939. The harbour works were commenced in 1855, with a view to the removal of the bar which obstructed the entrance to the port, and the deepening of the water in the bay. The engineers had to contend with very great difficulties and the improvements in the condition of the bar is largely due to the use of suction dredgers and the creation of sand traps. The first mail boat to cross the bar berthed alongside the quay in 1904. A graving dock, the biggest in the southern hemisphere, is 1166ft. long and 110ft. broad at the entrance. It cost more than £1¼ million. The splendid harbour facilities, the cheap and abundant supplies of water, electricity, and coal, and its ample area and cheap labour, together with the great enterprise of its inhabtants, mark out Durban as a great manufacturing and commercial centre of the future. The port handles a great deal of the output of the Natal collieries. An extensive area of the bay is equipped as a modern seaplane base. Durban is four days' flight from London and within a week of Australia.

In 1876 Sir John Coode visited South Africa, inspected the various ports at which works were being carried out under his direction, and also reported on harbour matters at Mossel Bay and other places. Considerable extensions at several ports followed this personal inspection. The capital expenditure on a harbour scheme subsequently designed by Mr. J. F. Craig for Port Elizabeth was estimated at about £3 million. It provides an inner basin of 314 acres protected by a solid breakwater, 4850ft. long.

East London is the only river port in the Union. It is at the mouth of the Buffalo River. Works now include a turning basin, so that the largest ship can turn in the river. The main protection is a breakwater, 3400ft. long. The harbour works cost over £2 million.

Simonstown was used for many years as a naval base, but the facilities there were not very extensive, and during the emergency of the war, additional arrangements have been made to deal with the largest naval vessels needed to protect commerce in the adjoining oceans.

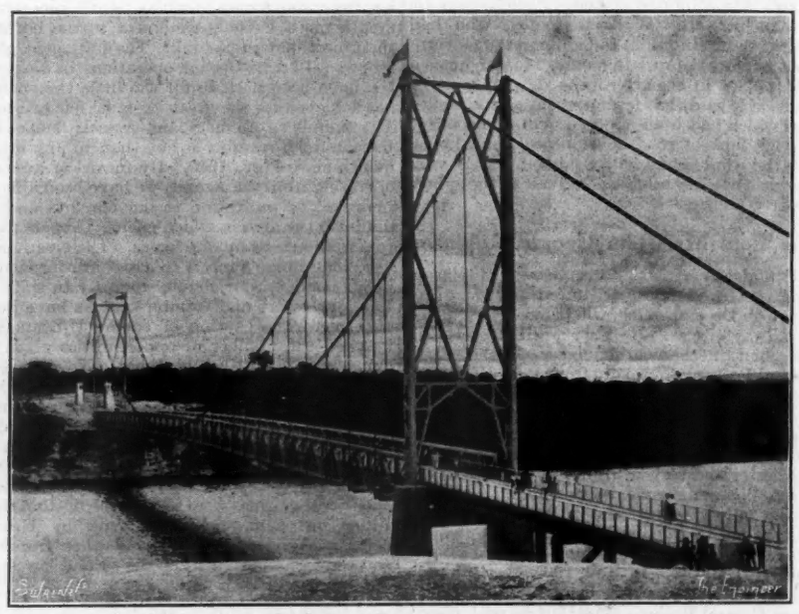
The port of Walvis Bay lies 800 miles north-west of Cape Town. It is believed that it will play an important part in the development of Southern Africa, and especially of the territory of South-West Africa, which has an area double that of Southern Rhodesia. The coast line is 1000 miles. The best means of entering the territory are by sea at Walvis Bay, or by rail from Cape Town to Windhoek, 1383 miles. The total rail mileage in the territory (1938) was 1493 miles. In that year the accumulated deficit on the railways and harbours exceeded £3½ million. There are over 20,000 miles of roads. Ten railway motor services total 902 miles. Taxation on diamonds has been the chief source of revenue. Other minerals known to exist in payable quantities are tin, copper, coal, lead, iron, vanadium, wolframite, and tantalite.

The port of Beira in Portuguese East Africa was constructed by British engineers, and is the terminus of the railway which they built in order to export minerals, &c., from Southern Rhodesia.

TECHNICAL EDUCATION

In 1916 Parliament instituted legislation to provide three universities in the Union—one, at Cape Town, incorporated the South Africa College, founded more than a century ago; the Stellenbosch University incorporated the Victoria College; the University of South Africa was established with six constituent colleges. In 1922 the University of Witwatersrand replaced University College, Johannesburg, the name assumed by the South Africa School of Mines and Technology when other departments were added to the original technical branches. In 1930 the Transvaal University College became the University of Pretoria. Constituent colleges of the University of South Africa numbered five. One, at Grahamstown, is named after Rhodes; another, at Bloemfontein, after Grey.

Full courses of engineering are provided at the Cape and Witwatersrand Universities, the latter offering a full course in mining engineering. In 1939 it was my privilege to address the Cape University students. The situation, equipment, and high standard of instruction created a most favourable impression. There are eight technical colleges controlled by the Government. That on the Rand had over 10,000 students. There are part-time technical courses in many State schools.



OTTO BEIT ROAD BRIDGE OVER ZAMBESI RIVER

THE WAR EFFORT

Under the brilliant leadership of General Smuts, South Africa quickly geared its industries for war production. Millions of replacement parts for tanks, aeroplanes, guns, &c., have been made and shipped or flown to the fighting front. The Rand engineering shops made bombs and other munitions. The first steel plant to be erected in South Africa has supplied the material. Manufactures never before attempted have been produced, and new industries will continue after the war. As in other parts of the Empire, the Union concentrated at first on production and plans for the war, but more recently plans have been

prepared for the great changeover to peace conditions. "More than social security is required," explained General Smuts. "What we want is not only social security, but the raising of the whole standard of society." Even before 1939 there were many mechanised industries, but the number has been greatly increased.

In 1938 the gross output of industry in the Union was valued at £187,400,000, of which nearly 94 per cent. was from private establishments. The wage bill was more than double that of five years earlier. Employed in industry (excluding mining and quarrying) there were 143,760 Europeans and 204,760 others, the former receiving 72 per cent. of the total wage bill.

The City Council of Johannesburg has under consideration new schemes estimated to cost £20 million. There is every reason to believe that the development of the huge areas north of the Union, the excellent rail and road communications in Southern Africa, and the spirit of adventure and initiative which has done so much to utilise the natural resources of the country will result in new engineering works and in the consequent increased prosperity needed for "raising the whole standard of society," as suggested by General Smuts.

BIRCHENOUGH BRIDGE, RHODESIA

The Rhodesias

Many romantic stories that reveal the courage, resourcefulness, and determination of British explorers, colonists, and engineers in various parts of the Empire have been told, but those concerned with the Rhodesias include episodes that happened in the lifetime of many of us who remember the excitement they caused, not only in our own country, but in other parts of the world. The story of the spread of civilisation northwards to Central Africa begins with the important concessions obtained from the native Chief Lobengula by Rhodes in 1888, and the birth of the British South Africa Company, better known as the Chartered Company. The story of the strength of purpose and courage of Rhodes may fade, but there is a huge territory of 440,674 square miles named after him in Africa that will remind future generations of this remarkable Englishman. His work influenced the development of engineering schemes in areas north, east, and west of the Rhodesias.

"It is for man to tame the chaos; to scatter the seeds of science . . . that climate, animals, and men may be milder." That has happened in the Rhodesias. The British made a smooth path for others to follow them through unknown and almost impossible confusion. The adventurous and energetic Englishmen, who were determined to develop the natural resources of territories in Africa that were eventually brought into the Empire, constructed important engineering works in the adjoining Portuguese and Belgian Colonies.

It is impossible to understand the lines along which South Africa is developing without a consideration of the influence exercised by the discovery of great mineral wealth in the Katanga district of the southern Belgian Congo, and the railways joining Rhodesia to the Portuguese port of Beira on the east coast, and Benguela on the Atlantic.

Responsible government was granted by the Crown to Southern Rhodesia; North Rhodesia became a Crown Colony. The Zambesi River now forms the boundary between the Rhodesias. There is telegraphic or telephonic communication between all the principal towns and police stations, and in 1934 a telephone service with Great Britain was inaugurated. There are wireless stations at Salisbury and Bulawayo; a beam wireless at Salisbury has direct transmission to London. There is a broadcasting service.

The European population of Southern Rhodesia was (1941) almost equally divided between the occupations of agriculture, commerce, mining, secondary industries, and in Government service. A considerable part of the country consists of an elevated plateau standing from 3500ft. to 5000ft. above the sea. The watersheds and upper plains are most suitable for Europeans, but conditions naturally vary in a territory about half the size of Europe.

The population of Southern Rhodesia is near 1¼ million, of whom rather less than 70,000 are Europeans. Of the total value of exports (£15 million) in 1940, gold headed the list. Of the exports, 87 per cent. went to the British Empire. The value of machinery and metals imported in recent years exceeded £3 million per annum.

Since the occupation of Southern Rhodesia by the British, up to the end of 1938, the total value of the mineral yield was over £147 million, of which gold contributed about £112 million. In 1933 a shipment of cobalt valued at £601 and weighing 1503 lb. was sent from North Rhodesia. In 1938 about 3¾ million pounds came from the Nkana mine, the largest producer in the world. Until recently, cobalt was used only as a colouring agent, but it is now the chief constituent in a valuable steel alloy; also in iron for magnets. About 18 tons of mica were obtained (1937) in Southern Rhodesia and nearly 9000 lb. from North Rhodesia.

North Rhodesia, with an area of about 290,320 square miles, has a slightly larger total population than Southern Rhodesia, but fewer Europeans. The total value of exports (1938) was slightly in excess of £10 million, the value of copper being £8,858,570. Metals constituted 97 per cent. of the total value of domestic exports in that year, of which 88 per cent. represented copper. Mineral rights within the territory are still vested in the Chartered Company. The value of these has been placed at £5 million.

Zinc is worked on a large scale at Broken Hill, North Rhodesia. The yield for 1936 was 20,730 tons. The ore is widely distributed in Southern Rhodesia, but in 1928 the yield ceased with an output of 182 tons. The Colony produced 2735 tons of manganese in 1938.

Rhodesia and New Caledonia, in 1913, contributed nearly 90 per cent. of the world's supply of chromite, the figures (in metric tons) of production for that year being 57,517 and 63,370 respectively. Southern Rhodesia, in 1913, exported (in short tons) a total of 62,899, of which 27,440 went to America and 13,830 to France. In 1938 205,052 tons of chrome ore were produced, valued at nearly £250,000, in Southern Rhodesia. The pre-slump estimate for world requirements was 400,000 tons.

Tin has been found in Southern Rhodesia, but the results of considerable capital expenditure have so far been disappointing. Asbestos of excellent quality is found in healthy districts. Rapid progress in its recovery has been made since the opening of the Shabani Railway in 1928. In 1940 the value of asbestos exported was nearly £1½ million. Incidentally, there is a huge belt over 250 miles from 4 miles to 20 miles wide from 30 miles south of the Orange border to Bechuanaland, with practically inexhaustible asbestos deposits. It is the largest asbestos producing area known.

The Katanga Copper Mines

In order to understand the engineering development of South Africa it is essential to mention the remarkable mineral wealth in the Katanga district of the Southern Belgian Congo adjoining Rhodesia. Within this area, about 200 miles long, with a width of from 16 miles to 60 miles, there have already been found 150 deposits of various minerals. In 1937 over 1½ million tons of copper had been won from the mines. Railways run to Katanga from many directions: from Cape Town, Natal, Lourenzo Marques, and Algoa Bay in the south; from Port Franqui to the north-west; from Lobito in the west; and from Dar-es-Salaam in East Africa a line runs from Lake Tanganyika and is connected by rail and river with Katanga.

Production of copper began in 1911; in 1930 the production, in metric tons, was 138,949; 2116 whites and 21,500 natives were employed in the mines and smelters. In 1938 the quota reduced production to 125,000 tons, when the number employed was reduced to 720 whites and 19,000 natives. The maximum possible output is estimated at 225,000 tons per annum. Immense developments, costing over £6 million, including plant for electro-chemical treatment of low-grade copper ores, have been carried out since 1921. It is not too much to say that the dynamic personality of an Englishman, Robert Williams, created this great industry in the Belgian Congo, and thereby became the chief influence in opening up the country. He was a great friend of Cecil Rhodes; he

died, honoured by Belgians and South Africans, in 1938.

RAILWAYS IN SOUTHERN AFRICA

Railways are usually hard business propositions, which are built, as a rule, to link one industrial point with another, rather than to link two political areas. The colossal political project envisaged by Rhodes, the all-red Cape to Cairo route, was affected by the discovery of the wonderful coal deposit at Wankie and the big mineral deposits at Katanga, west of the Rhodes route, and the line drew away into the Belgian Congo.

A number of branch lines have been built to serve farming and mining areas. The capital cost of the combined undertakings (including the Beira Railway) was about £25 million sterling. It has been estimated that, on the average, railways in Southern Africa cost £7000 a mile to build.

The combined railways of the Rhodesias consist of about 2443 miles owned by Rhodesia Railways, Ltd., 204 miles owned by the Beira Railway Company, Ltd., and 204 miles owned by the Shabani Railway Company, Ltd. In 1938 the staff consisted of 4333 whites and 14,159 natives and coloured.

THE WORK OF BRITISH ENGINEERS

When we read the biographies of famous British engineers who worked during the last century—biographies that are all too few in number—we begin to realise how valuable have been their services to the Empire and to the development of many foreign countries. Their work has transformed huge areas in Africa.

Sir Francis Fox, in the volume "Sixty-three Years of Engineering," relates that his father was consulting engineer to Cape Colony (1864–67), when he designed and carried out the first railway in that part of the Empire. Sir Francis and his brother were, later on, associated with Sir Charles Metcalfe—an intimate friend of Cecil Rhodes since their undergraduate days at Oxford—in the building of railways in Africa. We are told that Sir Charles had a remarkable *flair* for finding the best route for a railway. He walked over hundreds of miles, marked on the map the direction of the route he thought best, and when the survey parties had gone over other routes with levels and theodolites, and also the one he walked over, it was found that the best result invariably agreed with the route outlined by Sir Charles.

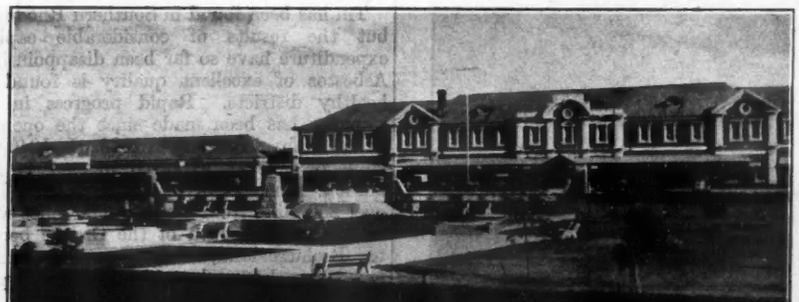
Rhodes requested Sir Charles Metcalfe to span the Zambesi, and that great engineer designed the famous bridge situated in perhaps the most wonderful setting of any such structure in the world. When Sir Robert Williams discovered the great copper mines at Katanga in Belgian territory, the railway of Rhodes was pushed on to Elizabethville, and thus coal from Wankie was made available for Katanga, heavy machinery was easily transported there, and the output of copper was carried to the world's markets.

ROADS IN THE RHODESIAS

When the Chief Road Engineer, Mr. F. T. Stuart Chandler (who has just retired), assumed office eighteen years ago there was not a single road bridge or culvert in Southern Rhodesia. To-day there are thirteen high-level bridges, 366 low-level bridges—the capital cost being met from a fund bequeathed by the late Mr. Alfred Beit and administered by the Beit Railway Trust—and 5742 culverts.

In 1925 practically all roads were mere tracks wandering through bush. Since then 3000 miles have been re-aligned, some 2500 miles gravelled and drained, and 2123 miles laid with tarmac strips. As the traffic is not great, that type of construction is suitable and very economical.

For many years the impenetrable territory in the middle of Africa separated the navigable Nile from the Victoria Falls and the Cape in the south. There is now the Great North Road, which is a highway of great importance to the development of Eastern and Central Africa. Lord Delamere in 1926 said at the East Africa Conference: "Anyone can get into his car anywhere in South Africa now and get out of it again on the navigable Nile." Motor-cars can now be seen daily in the areas where formerly Livingstone and Stanley endured such intense hardships.



BULAWAYO RAILWAY STATION

The distance by way of the Great North Road from the Victoria Falls to Rejaf, on the navigable Nile, is roughly 2780 miles. The road passes through Livingstone, Broken Hill, in Northern Rhodesia, on to Abercorn, near the southern edge of Lake Tanganyika. Then it goes almost due east across to Iringa, due north to Dodoma, intersecting the Dares-Salaam Railway to Lake Tanganyika. It reaches Nairobi and winds on 780 miles to Rejaf on the Nile in the Sudan. During the dry-weather months numbers of travellers have motored along it from the Victoria Falls to the Nile. It can, however, scarcely be a road used for commercial traffic until there is much more economic development in the areas through which it passes. Air travel progress has affected the urgent need for improvements. For land transport the road provides the shortest route between Pretoria and Nairobi. The East Central African dominions are eager to improve this transcontinental artery. It is one of the most romantic highways in the world. It provokes memories, rich and splendid, of the early explorers, and offers a great variety of scenery and opportunities to become acquainted with African fauna and flora.

THE OTTO BEIT BRIDGE

The most impressive work done by the Beit Trust has been the building of the Otto Beit bridge. This bridge links Northern and Southern Rhodesia across the Zambesi River and is one of the longest suspension bridges in the British Empire. It gives a clearance above waterway of 50ft. at ordinary water levels. The bridge carries an 18ft. roadway and two 3ft. footways. In addition to the main river crossing, there are four 40ft. approach spans at the south end of the bridge.

All the foundations are on rock near the surface. The weight of fabricated steelwork is 1060 tons. The cables weigh 200 tons and the reinforcement some 150 tons. The whole of the steelwork was manufactured and fabricated at the contractors' works in Middlesbrough. The cables and reinforcement were also their manufacture. The main span is suspended by cables anchored into the rock on either bank and passing over towers 125ft. high. The cables are 35ft. apart, placed outside stiffening trusses, which are 14ft. and 30ft. part. The bridge deck rises 24ft. in crossing owing to the northern bank being higher than the southern.

THE BIRCHENOUGH BRIDGE

The arch of the Birchenough bridge in Southern Rhodesia over the Sabi River was completed in 1935. This work represented the conclusion of an exacting steel erection operation carried out under most difficult conditions in the heart of Africa. The bridge is a single span of 1080ft.; it forms a link in the roadway to Umtali, and marks another stage in the rapid development of Rhodesia. It was built out section by section from each bank of the river, supported by steel wire cables. The material for the whole of the structure was made and fabricated on Tees-side by Dorman, Long and Co., who also built the Otto Beit bridge. Chromador steel was used throughout the arch, thus enabling the engineers to secure a lighter structure for a greater span than had ever formerly been possible. The whole bridge represents a material advance in the science of long-span bridge building; it successfully demonstrates the possibility of producing a structure of great span (the third longest arch in the world), at a cost no greater than that of a series of shorter spans. The structure was designed by Mr. Ralph Freeman, as consulting engineer to the Beit Trust, who also designed the Otto Beit bridge.

It has been possible to include only a brief outline of the rapid developments that have taken place in the Rhodesias and adjoining territories. They have already yielded up vast quantities of valuable minerals and sent out for export a great deal of agricultural produce. The main factor in bringing this huge area within the orbit of world trade has been the works constructed by British engineers, mostly financed in London. It is obvious that much remains to be done. We may therefore look forward with confidence to an increase in the prosperity and in the number of white residents in the Rhodesias, an area with many attractions for men of energy and enterprise.

(To be continued)

BOMBS AND COAL.—At a recent conference on Industrial Fuel Efficiency in Newcastle-on-Tyne, it was asserted that every time our airmen dropped 4000 tons of bombs on enemy territory those bombs had used 40,000 tons of coal.

Institution of Mechanical Engineers

AT an extra general meeting of the Institution of Mechanical Engineers held last Friday, December 10th, the following papers were read :—

"A Survey of Plastics from the Viewpoint of the Mechanical Engineer," by S. Livingston Smith, D.Sc. (Eng.), M.I. Mech. E.

"Moulding Plant for Plastics," by J. L. Daniels, B.Sc., M.I. Mech. E.

On another page of this issue we begin to reprint the first named of these papers. The following discussion ensued :

Dr. W. D. Douglas said that engineers were now faced with the necessity for designing with considerable accuracy in materials which to a certain extent were alien from their experience. The general group of so-called plastic materials was a case in point. Here they came up against a difficulty, namely, that the design rules which had served so well in the past were no longer entirely reliable. This was not entirely restricted to materials of the plastic category. A good deal of attention was now being paid to the use of metals hot. A metal hot did not behave in the way the metals to which they were accustomed behaved when cold, but the metal hot had a good deal of similarity in behaviour to some of the plastics. The rate of creep and of flow even at working stresses became of importance in those materials. One of the difficulties in developing plastics for structural use was that, in comparing engineering data and engineering design rules, matters were made difficult because they did not know exactly what they wanted. If they had to alter their engineering rules they might need certain new properties or the properties might have to be assessed in certain new ways. For that reason a good deal of the work done so well at the National Physical Laboratory and elsewhere was aimed at finding what properties of the new materials were essential for engineering design purposes.

Mr. E. M. Wilkins agreed that plastics had to be handled very carefully, but he wished also—speaking as a chemist—to put in a plea for a certain amount of assistance from engineers generally in regard to one question which he thought very important. Dr. Smith had mentioned that the attractiveness of the first group of plastics was in their ease of production in large quantities, referring in particular to the plastics based on moulding powders from thermo-plastic resins. But the second class he had mentioned, namely, the laminated, reinforced structures, were at present handled largely by means of machining, and their cost was often very high. There was a growing need for some research to be done from the engineering side on the production of reasonably cheap moulds.

Dr. N. A. de Bruyne said that he had taken the results given in the paper of strut tests on reinforced cellular plastic and compared them on a strut weight basis with wood. The result was to show that for short lengths there was nothing to choose between wood and cellular plastic, while in longer lengths the wood had the advantage very definitely. He would say that there was no very good reason from the structural point of view for disintegrating that wood, shaping it into paper, impregnating it, and moulding it under pressure into a cellular plastic. Some general considerations led to the same answer. Taking Table X, showing mechanical properties of a board made with high-density kraft paper, he proceeded to discuss the corresponding figures for spruce, and these worked out as follows :—

$$E/\rho = 3 \cdot 28 \times 10^6.$$
$$E/\rho^2 = 72 \cdot 8 \times 10^5.$$
$$E/\rho^3 = 1616 \times 10^4.$$

He did not bring forward those figures in any disparagement of plastic materials, but he thought they ought to be kept in mind, because if one expected too much of the plastics he would be disappointed. Of course, structural strength was only one aspect. Plastics might have very good properties from the point of view of ease of production, electrical characteristics, freedom from corrosion, and so on, but from the strength point of view they still had a long way to go.

He congratulated Dr. Smith, and, through him, those who had worked with him, on the work they had done in making low-pressure mouldings. He thought that to some extent that was the answer to the previous speaker. They had shown how, even at 200 lb. per square inch, the pressure used in making plywood, quite reasonably good materials had been made. It was necessary to go further yet, and he understood that they claimed to have done so in America by the use of mere contact moulding. There was a great future for low-pressure moulding, providing that not too much was asked of the resultant materials.

Mr. H. C. Young said that a note of warning was necessary. At the present moment as a war product urgently in demand a thermo-plastic had come into being. It had replaced a semi-ebonite or a hard rubber. But let the prices of the two materials be considered. When the rubber material was available, it was put on to the market at the basic price of 5½d., whereas the plastic which was replacing it was at the basic price of 1s. 3d. He thought it would be found that there was no need to apologise for examining the commercial aspects of plastics. It was the predominant factor which would go to make for its success or failure when conditions became normal.

If the plastic material was to come into its own it must be compared with what had gone before it. Metals beat it on high tensiles, and rubber and other substances beat it on high extensibility, and it fell between the two. But it could fill a requirement in its own particular markets.

Dr. Smith had referred to laminated materials. Here he could strike a note of hopefulness, citing the instance of linoleum. Linoleum was sold only because of its cheap manufacturing methods. It replaced rubber because somebody was bold enough to make a real bid at a manufacturing method. He would suggest to Dr. Smith that he should follow some such procedure as to go through the bath and through the drier, and then straight to the press. In the latest method of pressing discovered in America the material was fed round a drum. The drum had enfolding it outside the material a steel belt, which ran on a suitable set of pulleys. By suitable means an embracing pressure was obtained on the drum, which continued to revolve. That machine was to-day pressing conveyor belts and transmission belts, involving a pressure of anything up to 600 lb. per square inch. It had done away entirely with hydraulic presses, and it had the advantage that the material was continuously processed. If that could be applied to the method of making these plywoods, a considerable reduction in cost would be obtained. There would be a large saving in heat, and a very large saving in labour. He believed that the labour cost came down to something like one-ninth.

Mr. Harry Knott remarked that parts of certain machines used in the textile trade required, in addition to the usual mechanical properties of strength, stiffness, and so on, considerable resistance to chemical attack by materials like dilute sulphuric acid, carbon bisulphide, and others less virulent than those. He visualised the possibilities of building a machine largely out of laminated sheet and impregnated wood. What would be the result, from the point of view of resistance to chemical attack, on the life of a structure made of those materials? Would it be more vulnerable to the attack of such acids than an ordinary solid structure?

In the results of prolonged loading tests, with creep at constant stresses, some remarkable properties were demonstrated. Materials were shown stressed at 2·02 tons per square inch, in which there was steady creep over a period of forty-five hours. But was there any information as to the probable creep characteristics of such material after a period representing the reasonable working life of parts of a machine; that is to say, several years?

Major James Gardner said that the first point that struck him as being important to the mining industry, and in which plastics might help, was in connection with shaft winding. A good deal of trouble developed from winding ropes deteriorating through fatigue and various other causes. The deterioration took place at certain points, first of all the point where the rope came to rest when the cage was at the bottom of the shaft, and again at the point when the cage was at the top of the shaft, and where the rope passed through the drum. It seemed to him that perhaps lining the large diameter winding pulleys, of 18ft. to 20ft. diameter, which had a groove about 9in. deep, with plastics might help to damp out some of the vibrations at the points mentioned and to eliminate the winding trouble in this respect. Would it be possible to replace the bronze lining of pumps that had to deal with highly corrosive water with plastics? Was the material of sufficient strength to use for centrifugal pumps? Would it be possible to mould in plastics gear wheels of 6in. diameter with ½in. pitch, and, say, 8in. and over diameter, and 1in. pitch and upwards? That might be a direct application to mining. Again, there was the question of the lining of chutes, both with a view to countering erosion and to damping out vibrations. Was that a possible application?

The Chairman said that it was hardly fair to ask the authors to reply at that late hour, in view of the large number of questions which had been raised. They would have the opportunity to do so in writing.

RIPPLE ROCK PROVIDES PROBLEMS.—The blasting of the Ripple Rock in the tide-swept water of Seymour Narrows on the British Columbia coast, about 100 miles north of Vancouver, is providing problems for the engineers and drilling crews who are engaged in its removal. Work was started earlier this year by the British Columbia Bridge and Dredging Company, which constructed a special 150ft. drill barge from which to carry out the drilling operations. This barge is held in position by six concrete anchors lying in the 300ft. deep bed of the channel, but the tides in the Narrows repeatedly snap the heavy anchor cables and threaten to wreck the drilling equipment.

A High-Pressure Superimposed Power Plant

By D. RONALD WILLIAMS, B.Sc., (Eng.), M.I.E.E., F. Inst. F.

No. III—(*Continued from page 472, December 10th*)

(8) GENERAL DESIGN OF PLANT (*continued*)

(*b*) *Turbo-Alternator.*—The turbo-alternator is a direct-coupled set running at 3000 r.p.m. Careful consideration was given to a high-speed turbine driving an alternator through a speed-reducing gear, but as the efficiency of this latter arrangement was only about 2 per cent. better than the direct-coupled set, the direct-coupled alternative was adopted.

The turbine is noteworthy for its compactness of design, the overall length being 14ft., and the mean diameter of the reaction stages 18½in.

Steam at 1500 lb. per square inch is admitted to the turbine at four oil-operated valves and expanded across a single-stage impulse wheel of about 34½in. diameter to a pressure of approximately 1200 lb. per square inch, further expansion taking place across thirty reaction stages.

The rotor is built up from several forgings, the dimensions of which are small, thus ensuring complete reliability of the material employed. The casing is a special high-grade cast steel, while all parts in immediate contact with the higher temperature, such as the valve casings, nozzle boxes, and nozzles, are made of molybdenum steel. The fabricated nozzle boxes which can be seen on the cross-sectional drawing, Fig. 10, are a special feature of this turbine, and are manufactured from special alloy and welded into the turbine casing prior to machining.

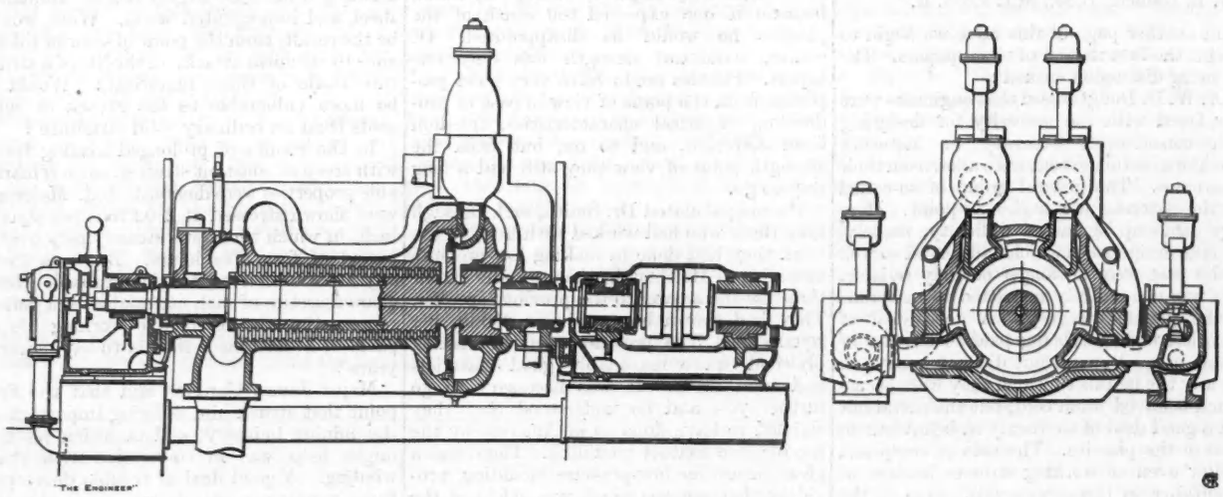


FIG. 10—HIGH-PRESSURE TURBINE

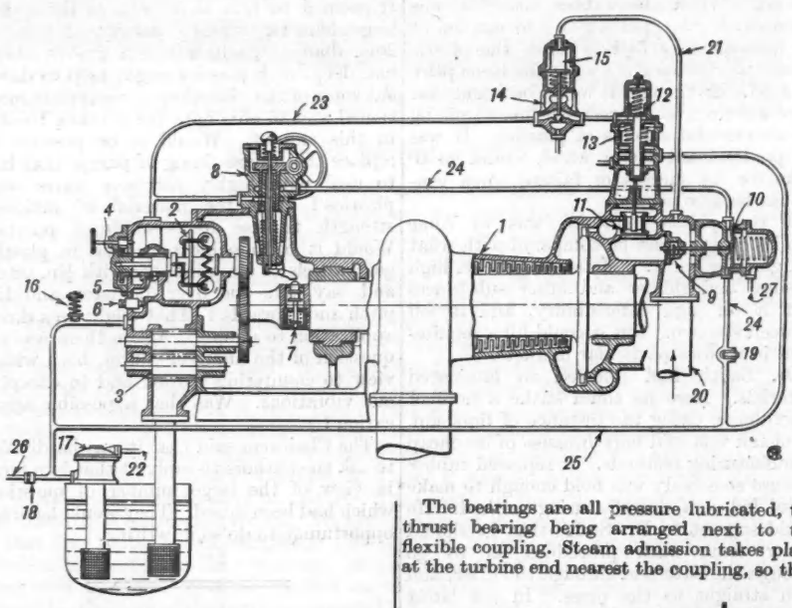


FIG. 11—GOVERNOR DIAGRAM OF TURBINE

The bearings are all pressure lubricated, the thrust bearing being arranged next to the flexible coupling. Steam admission takes place at the turbine end nearest the coupling, so that the turbine can expand freely towards the governor, which is arranged at the free end of the machine.

The turbine is provided with pressure oil-operated stop valves, steam pressure regulator, speed and emergency governor (Fig. 11).

The turbine admission valves can be put under the control of a speed governor as in any ordinary turbo-alternator. This procedure is, however, only used for starting up, and as soon as the generator is on the bars the speed governor is set high and the oil-operated admission valves are placed under the control of the pressure governor. This keeps the admission pressure constant, i.e., the admission valves are opened to such an extent that all the steam available is passed through the turbine, so that the loading of the machine is only dependent on the quantity of steam available.

(*c*) *Boiler Feed Pumps.*—There are three eleven-stage centrifugal type boiler feed pumps, two running and one standby. The pumps are driven by 950 H.P. electric motors through speed-increasing gears with a ratio of 1480/4830 r.p.m.

Cast steel casings have been used, thus eliminating any possibility of external or internal leakage due to uneven expansion. The overflow pieces are of cast iron and impellers and guide wheels of chromium steel.

In view of the high temperature of the water (420 deg. Fah.) with which the pumps have to deal, these rest upon water-cooled supports arranged in a horizontal axial plane, thus always ensuring correct alignment of the pump axis with that of the speed-increasing gear. Special guides prevent any lateral movement of the casing. Expansion of the guide wheels is taken care of by special springs fitted into the end cover, while an expansion disc is provided to allow for expansion of the impellers.

The rear cover is of Siemens-Martin steel, the front cover—incorporating the suction branch—is of cast steel, while the delivery branch is cast in one piece with the pump casing. The shaft is of steel and runs in two white metal lined pressure oil-lubricated bearings, the oil being circulated through an oil cooler. The axial thrust of the impeller is taken up by a balancing disc of chromium steel.

Special consideration has been given to the design of the stuffing-boxes of the pumps. As

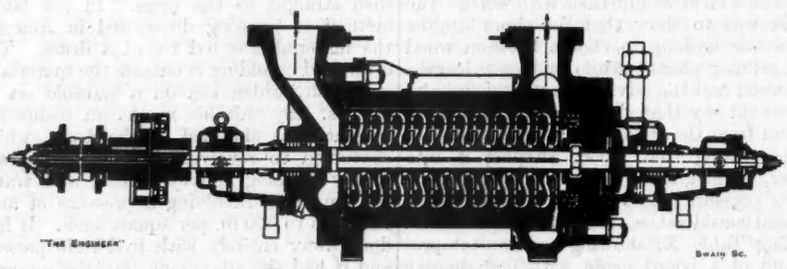


FIG. 12—BOILER FEED PUMP

will be seen from Fig. 12, the stuffing-boxes are not in direct contact with the very hot water in the pumps, but are sealed by introducing water at 180 deg. Fah. behind the stuffing-boxes at a pressure higher than the suction head on the pump. The sealing water for the glands at the suction end of the pump passes with the main water flow into the pump, while on the pressure side it passes out with the water escaping from the balancing disc. A small quantity, however, is allowed to leak to atmosphere through the stuffing-boxes, a method which has proved an effective means of lubricating and cooling the packing, which should not be allowed to run dry. The pump shaft is protected by water-cooled bushes, which can be replaced when worn, the cooling water reaching the bushes through the centre of the shaft which is hollow. The shaft is connected to the pinion shaft of the speed-increasing gear by means of a flexible coupling, the axial movement of which is limited so that the thrust of the gear—which is of the helical type—is transmitted to the pump shaft. This arrangement eliminates thrust collar difficulties on the high-speed gear shaft.

(*d*) *Feed-Water Heater.*—The feed heater, 38ft. high, 8ft. 2in. in diameter, designed for a working pressure of 370 lb. per square inch, is believed to be one of the largest all-welded vessels for this pressure in the country. The thickness of the mantle shell is 1⅞in., that of the dished ends 2¼in., the weight without platforms, valves, pipe lines, &c., is 39 tons, and the water content is 40 tons at normal level.

As this accumulator is subject to rapid change of temperature, owing to the fact that the line of demarcation between the water at a temperature of 420 deg. and the water at 180 deg. Fah. rises and falls according to the changing conditions in the accumulator, it was felt that a welded construction should eliminate the leakage which might occur if riveting had been adopted.

The body is made of Siemens-Martin steel having a tensile strength of 22·4–26 tons per square inch and an elongation of 26 per cent. The plates were bent cold on a machine which records the bending resistances of every sector, hard spots, or laminations of the plates showing up immediately. Spiral welding was adopted, whereby the longitudinal seams are located at an angle of 45 deg. to the direction of the main stress of material, the welding being carried out electrically in the double tulip form (Fig. 13).

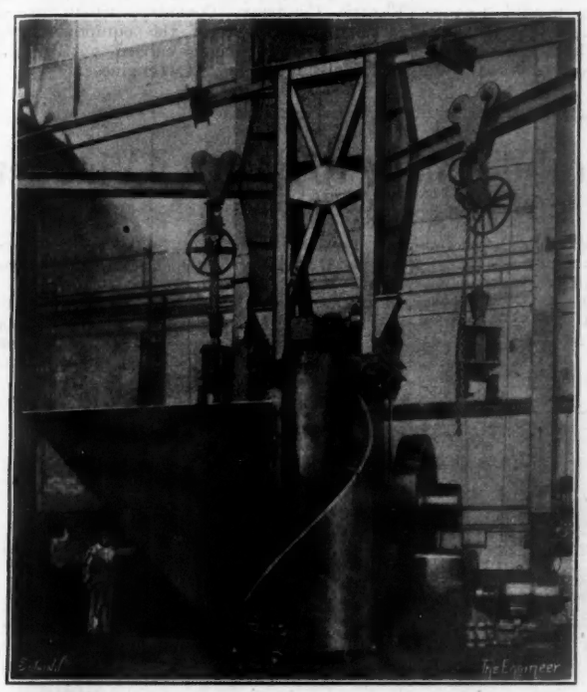


FIG. 13—BENDING PLATE FOR BODY OF FEED-WATER HEATER

The shell was annealed for stress relief in a special furnace.

The method adopted for measuring the heat content of the accumulator is of interest. As the cold and warm water do not mix in the vessel and both temperatures remain constant, the elongation of the shell is proportional to the actual heat content. The elongation is transmitted to a pilot valve connected to the regulating oil system and thus transformed into an oil pressure which can be indicated anywhere on an ordinary pressure gauge, which in turn can be calibrated in heat units. The accuracy of the heat content indication has been confirmed by means of checks carried out with thermo-couples.

(*e*) *Piping.* — The dimensions of the high-pressure pipes of cupro-molybdenum steel are as follows :—

Feed-water supply : 4½in. o.d. by ½in. thick.

Live steam to turbine (one main per boiler) : 5⅛in. o.d. by ½in. thick.

Wherever possible, flanges have been eliminated, the pipes being joined by oxy-acetylene cross welds. Special care was taken to allow for expansion without undue stress by the free use of loops, bends, and cold pulling.

Where flanges have been considered necessary, such as at valve positions, soft iron joint rings have been fitted. The studs are located as near as possible to the pipe and the nuts of special design are embedded in the metal of the flange, ensuring equal heating and cooling of the stud and flange. The studs are pulled up hand hammer tight.

Dawson joints with external bolts were used for the medium-pressure piping, the welding being carried out electrically.

(*f*) *Coal-Handling Plant.*—The coal is brought to the station from the colliery dust-collecting plants in steel tank wagons, consisting of three compartments, each holding 5½ tons. The contents of these compartments are discharged into intermediate feed bunkers by means of compressed air, the coal being then conveyed to the main bunkers in the boiler house by means of Redler conveyors.

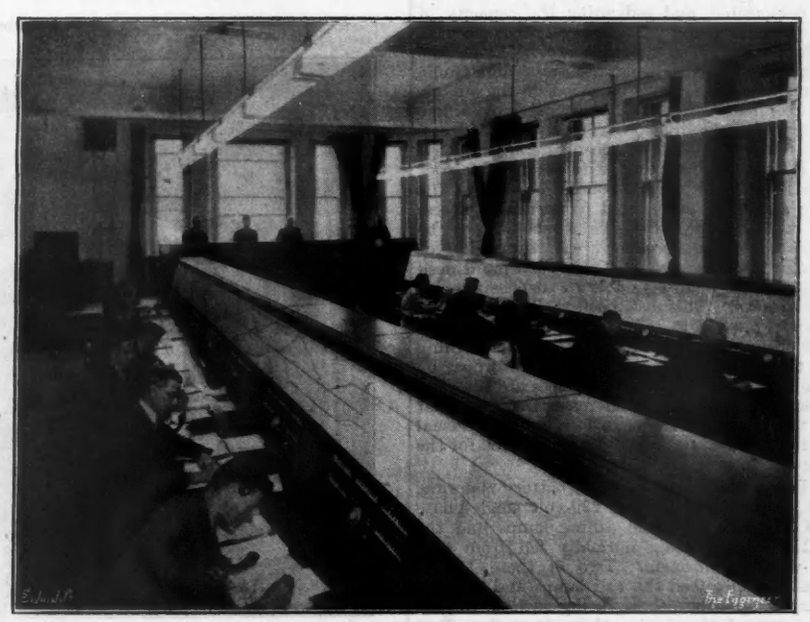
(To be continued)

New L.M.S. Divisional Control Office

DURING the blitz the centralised control office of one of the four operating divisions of the L.M.S. Railway was totally destroyed, following which the protected emergency accommodation, which was already equipped with the necessary telephone apparatus, was brought into use. The control shelter provided for the continuance only of essential work during air raids, and for occupation for brief periods during emergencies, when, say, damage was sustained to the permanent office. This was in accordance with the policy adopted in respect of all control offices on the L.M.S. system to ensure continuity of operation. In the case under notice, the emergency control shelter was designed to accommodate a staff of twenty-eight, but when, owing to the entire destruction of the main office, it became necessary to utilise it as the regular office, it had to be staffed by up to thirty-six persons on the day shift. Consequently, the staff was working under cramped conditions, and the continuous and prolonged occupation of the shelter, which is at a considerable depth below ground, with artificial lighting and ventilation in constant use, was impairing the health and efficiency of the staff.

It became necessary, therefore, to consider the provision of a new permanent installation, but as the staff was housed in quarters where it could carry on, work of a more pressing character on restitution of air raid damage and on urgent emergency schemes had perforce to take precedence over the production of designs for a new office. After plans had been drawn up, the equipping of the office involved the ordering and manufacture of large quantities of telephone apparatus, specially designed to meet the needs of the office, utilising components in heavy demand by the Forces, Civil Defence Services, and the G.P.O., and in order to avoid long waits for materials, a measure of priority was secured from the G.P.O. Precedence Panel through the Ministry of War Transport.

When deliveries were effected there followed a task of great magnitude in installation on the



NEW L.M.S. DIVISIONAL CONTROL OFFICE

site, involving the performance of processes of an intricate character, made more exacting by a shortage of skilled labour and the necessity, due to wartime conditions, for the utilisation of materials not so readily manipulative as their pre-war counterparts. The work having been successfully accomplished, the new office is now in full operation.

In order to minimise the labour and time factors a large room in an existing building was adapted as the control office, and an adjoining room divided into two portions to form apparatus and cloak-rooms respectively. On the main floor of the office are thirty-two desks laid out in two suites, each with sixteen desks in rows of eight, set back to back, but separated by a cable rack throughout its length. A dais across one end of the office accommodates desks for the head controller and two deputies (for Eastern and Western Areas respectively), with a further desk alongside, making thirty-six in all. The desks on the two inside rows of the suites accommodate the sixteen section controllers, and on the outside rows sit the controllers responsible for such specialised work as trainmen's relief, unbalanced engines, distribution of passenger and freight rolling stock, &c.

Fixed on the desk in front of each of the controllers is a lamp-signalling keyboard, giving communication with the telephone circuits required, and a switchboard is provided on the dais for circuit switching. Direct and instantaneous telephonic communication is provided with nearly 900 stations, signal-boxes, locomotive depôts, marshalling yards, &c., throughout the division, and with adjoining divisional and district control offices. All the thirty-eight control circuits involved are connected to each of the nineteen keyboards fitted at the chief controller's, deputy controllers', and assistant controllers' positions, but on the sixteen keyboards provided for the section controllers, selected control circuits applicable only to the areas dealt with are reproduced.

In addition to the normal control circuits, each keyboard caters for the following:—(*a*) Inter-communication facilities between all keyboards and the switchboard; (*b*) exchange facilities to the main station P.A.B.X.; (*c*) post-office trunk subscribers' facilities to enable earmarked P.O. trunks to be brought into use under emergency conditions. All the above facilities are reproduced on the switchboard, from which, in addition, extensions are provided to selected administrative officers.

Mounted above the keyboards on the section controllers' desks (the two inside rows), and covering the cable racks, are geographical train boards, executed in paint, giving a diagrammatic picture of the whole of the running lines and sidings for which each section controller is responsible, and indicating the capacity of loops, sidings, and yards, and all other essential information. These boards are holed for the pegging of cards displaying train and traffic particulars. They are balanced on the outside row of each suite by boards carrying a line diagram of the division. The train boards are 4ft. 6in. wide by 1ft. 6in. deep, and are mounted at a slope to correspond with the front face of the keyboards. These boards, as well as the line diagrams, are hinged to permit of access to wiring and to enable keyboards to be replaced when necessary. A simplicity of design has been achieved, the maximum desk space being made available by dispensing with desk racks. This has been accomplished by fitting drawers in the desks with racking for the custody of cards of various sizes, according to the requirements of the work performed by the individuals. All desk surfaces are thus free from obstruction, with one exception, viz., that of the engine controller, who relies upon visual indicators in the form of coloured cards for the regulation of engines.

Power for lamp operation, battery charging, &c., is obtained from a 230-volt single-phase A.C. supply, both the calling lamps and the V.E.S. lamps being normally fed from four 17-volt transformers. Two of these 17-volt A.C. supplies feed the call lamps and two the busy lamps, the cabling being such as to give a staggered distribution throughout the office. Automatic switches are connected to the two call lamp supplies, these switches being released on failure of the 17-volt A.C. supply, the call lamp load then being automatically transferred to the 18-volt common battery. Manual switches for the changing over from 17-volt A.C. to 18-volt battery operation are also provided. Under "mains failed" conditions, the visual engaged or busy facility is dispensed with.

The relay sets and controllers' common battery telephones are fed from duplicate 18-volt, 180-ampere-hour secondary cell batteries. A full-rate rectifier is provided for charging the idle battery, but, in addition, in order to obtain the maximum storage possible to meet "mains failed" conditions, and at the same time to keep the size of the battery reasonable, the battery in work is float charged by a separate rectifier at about 4 amperes. Three ringing-out batteries, consisting of 40-ampere-hour secondary cells, are charged from separate rectifiers.

The new office is unique in that it functions as a district control for the major portion of the division, and at the same time embraces the activities of a divisional control, and in respect of the number of working positions and intensity and volume of traffic controlled is said to be unparalleled in Great Britain and possibly the world. The design of the circuits and apparatus was developed in collaboration with the General Electric Company, Coventry, which manufactured the whole of the equipment, the installation work being carried out by the L.M.S. signal and telegraph engineer.

Repair of Bomb Damage to Railway Viaduct

THE London Road viaduct at Brighton consists of twenty-seven spans and at a height of about 70ft. above ground level carries the double track of the Southern Railway line between Brighton and Lewes. In plan it is built on a curve of a radius of about 10 chains. It was constructed during the years 1845–46 and took approximately eighteen months to complete, roughly 8,000,000 bricks being used in the work. It was designed by John U. Rastrick, who was also the engineer for the major portion of the main line between London and Brighton. Rastrick was a most capable engineer, and the works which he designed and

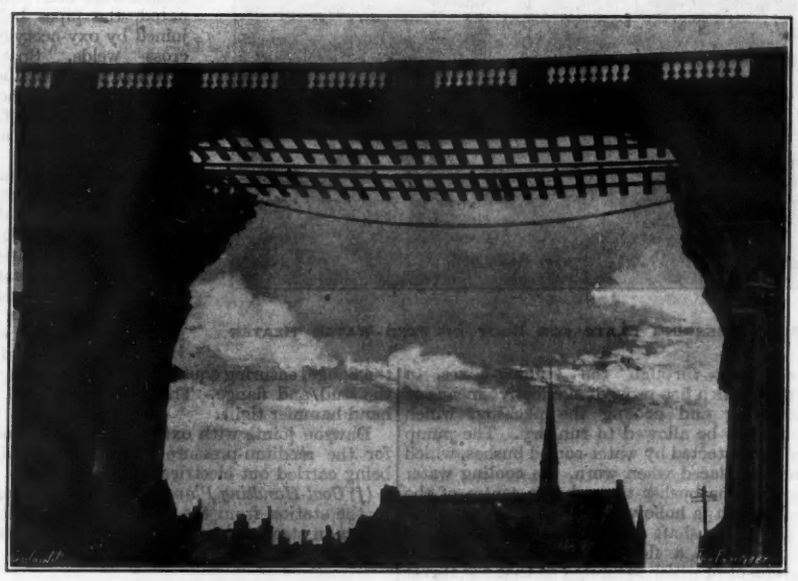


FIG. 1—DAMAGED VIADUCT

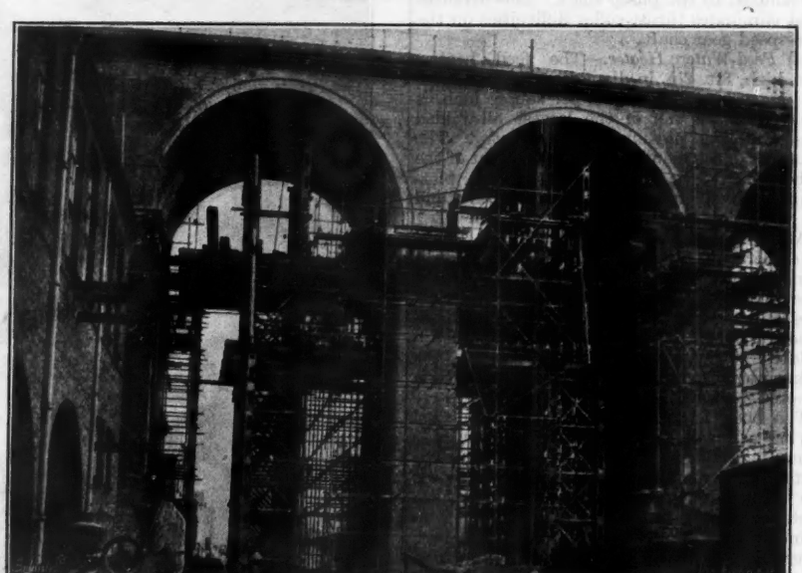


FIG. 2—REPAIR APPROACHING COMPLETION

which were doubtless carried out under his general supervision have well stood the test of time. As will be seen from the following description, only work of first-class quality would have resisted the violent attack carried out on it a few months ago without suffering complete collapse. During this attack a heavy bomb struck one of the piers and caused its collapse, together with that of the two arches immediately resting thereon, leaving a gap of about 70ft. span.

FIG. 3—TESTING TEMPORARY BRIDGE

Although the downward drag of the arches as they collapsed caused cracks in the main adjacent arches, they remained standing, and, indeed, the south side ornamental parapet remained self-supported over the gap for about six hours after the incident, before finally collapsing, as can be seen in the engraving, Fig. 1, which also shows the two tracks remaining suspended over the opening. A good deal of splinter pitting also occurred to one of the abutments. In order to prevent the collapse of the remaining piers on either side of the demolished pier, the first step taken was to tie the two adjacent arches each with four tie rods. The sectional area of each of these ties was 2in. square, as such material was available. The tie rods terminated with screwed ends passing through washer plates bearing against 14in. by 14in. timber walings placed along the faces of the piers, and were stressed by tightening the nuts with long-handled spanners. In order to prevent distortion of the arches on account of the stress in the tie rods, the piers were strutted apart by 12in. by 12in. timbers. These tie rods, walings, and struts were fixed from tubular scaffolding which was erected in a few hours.

Concurrently with this work the clearance of the 1600 cubic yards of collapsed masonry was also put in hand, five air compressors being brought up to the site with suitable pneumatic drills and other tools for breaking up the large masses of masonry, so as to enable a mechanical excavator to load the material into lorries for immediate removal. The site was cleared of this rubble in about three days.

As the damage to the viaduct stopped all rail traffic, temporary arrangements were made to accommodate passenger traffic by means of a bus service, but the resulting inconvenience made it urgently necessary for the line to be restored as quickly as possible. It was decided to erect temporary steel trestles of the military type as supports for a temporary bridge across the gap, and incidentally to utilise this falsework for strutting the piers on either side of the gap, and later on to support the centering for the reconstruction of the arches. The trestles, which were bedded on concrete foundations, were spaced so as to allow the new pier to be built between them. They supported the temporary three-span bridge, the waybeams of which consisted of six rolled steel joists, 18in. by 8in., under each track in the middle span, and four similar joists under each track in the side spans. The building of these trestles and the erection of the strutting, supports, and temporary bridge across the gap, together with the necessary testing of the structure, was accomplished within five weeks from the date of the bombing. Fig. 3 shows the testing in progress. Passenger service under a speed restriction was then restarted.

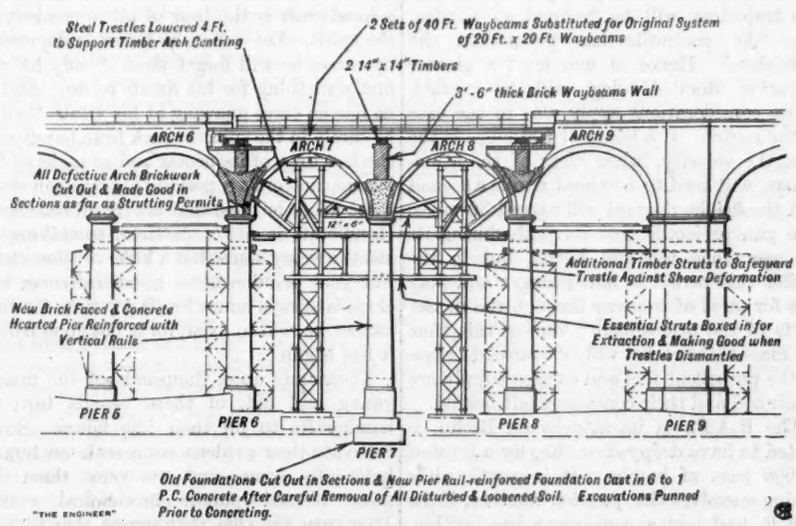

Steel Trestles Lowered 4 Ft. to Support Timber Arch Centring
2 Sets of 40 Ft. Waybeams Substituted for Original System of 20 Ft. x 20 Ft. Waybeams
2 14" x 14" Timbers
3'-6" thick Brick Waybeams Wall
ARCH 6
ARCH 7
ARCH 8
ARCH 9
All Defective Arch Brickwork Cut Out & Made Good in Sections as far as Strutting Permits
12" x 6"
Additional Timber Struts to Safeguard Trestle Against Shear Deformation
New Brick Faced & Concrete Hearted Pier Reinforced with Vertical Rails
Essential Struts Boxed in for Extraction & Making Good when Trestles Dismantled
PIER 5
PIER 6
PIER 8
PIER 9
PIER 7
Old Foundations Cut Out in Sections & New Pier Rail-reinforced Foundation Cast in 6 to 1 P.C. Concrete After Careful Removal of All Disturbed & Loosened Soil. Excavations Punned Prior to Concreting.
"THE ENGINEER"

FIG. 4—DIAGRAM ILLUSTRATING REPAIR OF VIADUCT

It then remained to rebuild the demolished pier and its two arches, and examination of the remains of the foundations of the demolished pier revealed that complete reconstruction would be necessary. The original pier had been constructed entirely in brickwork, but it was decided to make the new one of concrete with a brick facing, the new brickwork face as nearly as possible to match the existing work. The arches themselves were reconstructed in brickwork throughout, the choice of materials being governed by the rapidity with which the work could be executed. The sketch (Fig. 4) indicates the modifications of the temporary bridge to allow of the construction of the arches, and the work proceeded thereafter to completion at a very rapid rate. Fig. 2 shows the work completed, with the exception of the ornamental parapet, which has been temporarily replaced by a plain fence.

From the date of the bombing until final completion of the work was just over four months. The great bulk of the reconstruction work was carried out by the railway company's own staff, and the subsequent air raids during the period of reconstruction did not at any time result in any interruption of the work whatever.

Eyes as Weapons*

SPLIT-SECOND recognition of aircraft, ships, and other military equipment is a vital new weapon for United Nations' Service men, based on psychological experimentation and now widely put to use. The new Official Navy Recognition System grew out of years of experimentation by Dr. Samuel Renshaw and others in the Department of Experimental Psychology at the Ohio State University. It replaces the former system, in general use up to a year ago, of teaching men to distinguish friend from foe by recognising separate features or individual parts of enemy craft and equipment. This method trains men to recognise a total object after only a flash view, just as a child learns to read a whole word rather than each letter of the word, or as a man recognises an old friend instantly rather than by summing up known features. The method is considered both faster and more accurate than the older system, because recognition does not depend on a conscious mental process of adding together such features as wing and tail or turrets and stacks of the different craft.

The basic equipment used in the training is a collection of 2000 slides which present 168 different objects from every angle at which they might enter the field of vision. These slides are shown from a projector with a shutter which regulates the length of time the image is thrown on the screen. For new students speed for aeroplane shots is one-tenth of a second and for ships three seconds. At the end of the full 120-hour course aeroplanes are recognised at flying angles in one-seventy-fifth of a second and ships on glaring water can be identified after a one-second glance. Daily sessions with these slides so train the students that the image is literally hammered into the mind and reaction becomes automatic.

In addition to the vision training, men are given lectures on each type of ship, aeroplane, or armoured equipment as it is introduced to them. They are also shown movies, slides, and charts and are given models to study so that recognition of an object brings automatic understanding of its combat characteristics and possibilities.

Such instantaneous recognition may often save the life of a pilot or a ship in combat when the enemy may approach from any direction. As a result of this training programme, men on the ground can tell whether approaching aeroplanes or a distant tank column are hostile or friendly and men on ships during a fight can tell whether the aeroplane swooping low on the port beam is an attacker or defender. Accurate recognition at a distance is one of the most important elements of the entire system and is heavily stressed.

* From the *Industrial Bulletin*, October, 1943.

The Engineer

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ROCKET ATTACK

WRITING in these columns five years ago—August 19th, 1938—on the possibilities of long-range bombardment of cities, we pointed out that the German use in the last war of the "Bertha" gun for the attack of Paris, from a distance of 90 miles, was but a first step and that, "had the gun not proved readily capable of being pushed to this limit there was always the rocket in the background." In this war the rocket has been employed for many purposes by both sides, though not until lately for this form of attack. Such successes as it previously had were associated with short-range operations where accuracy of aim was more easily attained than at longer distances. The Germans have even employed a complicated scheme for the use of winged rockets with radio-controlled steering to attack both ships and aircraft, although only at ranges of a few miles, and even then with results which must have given little satisfaction to the user. In practice the irregular trajectory of the rocket limits gravely its operational value for long-range work, although for putting up what may perhaps be called a "statistical" barrage in the sky to oppose advancing aircraft this variability in flight cancels out in the mass and a useful weapon may well result.

When long ranges are required the problem before the designer becomes exceedingly complex. He has all the difficulties which he would have to face in the case of the long-range gun and, in addition, a great many more as well. In the case of such a gun as the "Bertha," a muzzle velocity of a mile a second was necessary to cover the distance, and this was only attained with difficulty and at the cost of very rapid barrel erosion. As we learnt in school days, the greatest range is obtainable, in a perfect vacuum, at an angle of elevation of 45 deg., although experience with ordinary artillery having air resistance to encounter showed the best angle to be many degrees less. With the "Bertha" type, however, it was speedily found that the longest ranges were, in fact, obtained at greater angles of elevation. This was because at such extreme ranges the altitude of flight carried the projectile so far outside the denser parts of our atmosphere that the trajectory closely resembled that attained under "vacuum" conditions. In fact, if one regards the effective part of the atmosphere (so far as resistance to motion is concerned) as confined to a sort of "blanket" 12 miles thick with "vacuum" conditions obtaining on the far side, one gets fairly near the truth and enjoys the advantage that calculations become much simpler. The first 12 miles will include at least 90 per cent. of the atmosphere and the best range will be obtained at such an angle of elevation that the trajectory will be inclined at 45 deg. once the projectile has penetrated the "blanket." Hence at gun level a greater elevation than 45 deg. will be needed. These considerations apply also to the case of the rocket. If a range of 100 miles is the aim, the velocity, when clear of the atmosphere, will need to be about a mile a second and the height reached will exceed 30 miles. The gun projectile gets its push during its passage along the gun barrel, but in the rocket this period is much longer and may last for most of the way through the denser parts of the atmosphere; during this time the mass of the rocket will, of course, decrease as the propellent fuel and oxygen supply are consumed and their containers left behind.

The R.A.F., in its attacks on Berlin, is stated to have dropped on the city a total of 15,000 tons of bombs. It is worth while asking ourselves the question whether, if the R.A.F. had had a convenient base within, say, 100 miles of Berlin, it would have been a better policy to have used rockets instead of aircraft? The design of a rocket for such a purpose might well call for it to have an initial weight ten times that of its final state, in which case the "useful" load would have much the same proportion to the starting weight as it would have in a bombing aircraft. Hence, if the explosive charge carried by the long-range part of the rocket were equivalent to that of a 4000-lb. bomb, its original weight might amount to as much as 40,000 lb., in which case to deliver 15,000 tons would require about 150,000 tons of rockets to be fired. This cannot be far from the total weight of the aircraft the R.A.F. did in fact use in the attacks on Berlin, but whereas the aeroplane losses may be put at about 5 per cent., that of the rockets would be 100 per cent. Hence the rate of replacement of the rockets would need to be no less than twenty times as high as that of aircraft. Even though the rockets may be simpler to make, this is a very unfavourable ratio to meet, to say nothing of the lower accuracy in aim. The problem before Germany must therefore be whether, with her intensive aircraft construction in peril of being permanently overshadowed by that of the Allies, she can release at this stage a labour force for rocket construction on such a scale as to produce any result likely to affect the issue of the war. Most of the 15,000 tons dropped on Berlin will have fallen within the built-up area, but if we had discharged rockets instead from 100 miles away it is probable that only a small proportion would have found the target. If Germany intends to attack any city in this country with this form of "new weapon," we think she will be making a very late start on on a very doubtful adventure, although a nuisance value it may certainly have. When the possibilities of rocket bombardment were under review in the R.A.F. many years ago, a leading Air Marshal is understood to have said that the side which employed such devices would certainly be the one to lose the war, for it would show a failure to distinguish between what was essential to victory and what was a mere diversion of effort.

Workshops for All

THERE is "no possible probable shadow of doubt, no shadow of doubt whatever" that a handicraft is the best of all re-creators of the spirit. Let a man be never so depressed by cares, he will forget them if only he can find something for his hands to do. And if he has no cares gnawing at his vitals, then is he surely in the spirit to suck from handicraft the last drop of its nectar and to make of his leisure, not only a period that has somehow to be filled, but one that is ever all-too short. Handicraft is not a pastime, something to kill the weary hours, but a killer of time itself. For your genuine home handicraftsman the clock is always hours too fast; time for him cannot be said to exist, for it has gone before it has begun.

Thousands upon thousands of the males, young and old, of these islands turn to handicrafts to fill their idle hours. Some cultivate their gardens, some seek out household jobs, some—and we count them the most blessed—pursue mechanical crafts. They turn, they file, they scrape, they fit, and they devise—O, happy men!—means of performing with unsuitable appliances jobs for which the latest advances of technology would be requisitioned by the professional. The name of model makers is legion. They are found in all classes of society and of all ages. Some of them make replicas on reduced scale, down to a complete marine engine on a threepenny bit; some, like Watt and

Parsons and a host of others, make miniature machines to test the practicability of new ideas, and yet others make models to demonstrate new inventions or—like Kelvin—to illustrate hypotheses. On a slightly different plane are those who construct with their own hands their own apparatus for researches on which they are engaged—Faraday and Rayleigh stand out as shining examples. "Let us," exclaimed Dr. C. R. Burch, some months ago, when he was presented with the Duddell Medal of the Physical Society, "let us, do all in our power to make it possible for the embryo physicist of the future to satisfy fully any desire he may have to acquire knowledge of crafts and skill in the use of tools." But it must not be compulsory. They must not be forced to learn a handicraft, but come to it of their own free will. When we recall all those to whom literature has been made distasteful by examinations in their childhood, our sympathies unite with those of Dr. Burch. The love of handicraft must precede the wedding with it; and in view of the common desire of men to create things, and, if they are engineers, to see the wheels go round, that should not be difficult. The will is usually there; all that it needs is opportunity and encouragement for its materialisation. Only those who have learnt to use their hands know the joy of doing so, and not alone the joy, but the instruction that is to be won thereby. "In my experience," to quote Dr. Burch again, "it has only been physicists who do not make their own apparatus who have been apt to persist in designing things that are quite incredibly difficult and expensive to make—difficult out of all proportion to the very small gain associated with the design in question."

These considerations bring us to a suggestion that may be worth investigation. All over the country there have sprung up war workshops of relatively small dimensions, and there exists a vast equipment of small tools from watchmakers' lathes to small automatics, woodworking tools, small furnaces, and hand tools in endless variety. Would it not be desirable and possible for municipalities or communities to acquire some of these small shops, equip them as far as might be needed, and to establish them as recreational centres where the local amateur handicraftsmen could spend their leisure hours in the pursuit of their hobby? Already the London County Council has done a good deal on somewhat similar lines, and the astounding popularity of the facilities presented leaves no doubt that the extension of the scheme, even down to quite a small scale, would meet with a hearty welcome.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CORROSION IN BOILERS

SIR,—My attention has been drawn to your report on a paper by Mr. W. F. Harlow on "Causes of High Dewpoint Temperatures in Boiler Flue Gases."

Corrosion on the gas side of boiler surfaces has been stamped out in first-class marine practice and in certain London power stations by the simple means of preheating the whole of the plant prior to igniting the fuel and maintaining the gas in all parts of the plant at something higher than the normal dewpoint temperature whenever bituminous fuel containing sulphur is burning.

Some years ago I met Mr. Harlow at a British power station. During conversation he agreed, as he must, that the products of combustion contain both H_2O and SO_2, and that the former must condense when the surfaces are cold, and combine with the SO_2 to form H_2SO_3—sulphurous acid—and that this was the first step in the promotion of the corrosion. Some corrosion would occur if there was no SO_2 present in the gases, owing to the combined effect of water and free oxygen. H_2SO_3 appears to combine slowly with free oxygen, forming H_2SO_4—sulphuric acid—which is the powerful corrosive agent. Mr. Harlow now appears to hold the view that H_2SO_4 only forms in the gas passages if SO_2 is first converted into SO_3 by the aid of a catalyst. Surely water, as distinct from highly superheated vapour, is required to combine with SO_3 to form H_2SO_4. If this is so, H_2SO_4 cannot be formed unless the gases are reduced first below the normal dewpoint and SO_3, like SO_2, at higher temperatures than normal dewpoint is innocuous in boiler gas passages. I am not a chemist, but it appears to me that the dewpoint can only be raised by increasing the H_2O content of the gases. Soot blowers with excessive steam consumption or which blow contra to the boiler draught and also water jets account for a deal of the corrosion now taking place. I do not know how a catalyst functions, and doubt whether the chemists do.

If SO_2 can combine with highly superheated vapour, then I may be wrong in stating that it is impossible for the dewpoint to be above the physical normal dewpoint. Assuming for a moment that the catalytic action converting SO_2 into SO_3 takes place, and that H_2SO_4 is formed whilst the boiler is steaming, and the dewpoint is raised as some plants are now operated, then to counteract this the air heater designer can prevent, say, from 50 to 80 per cent. of the trouble by designing the air heater with a reduced ratio of mass flow of air to that of gas over the critical surfaces of the heater, *i.e.*, at and near the air inlets. And/or he can advise his clients effectively to preheat the plant prior to lighting fires and to by-pass the air from the air heater during steam raising and very light loads. If he improves the design of the air heater he will get a greater all-round boiler efficiency, and his client will have much less trouble if and when neglecting the precautionary methods of operation which are now standard in first-class work, and which undoubtedly prevent the formation of the scale on the superheater, which is claimed to be the harmful catalyst. The ratio referred to is usually so high that, if the air heaters were made with more surface, some gas would be cooled well below the normal dewpoint even when the boiler was steaming at its full load and water would run down the heater continuously until the particular portion of the gas passages choked with "bonded deposit." Unfortunately, as the gas passages close with deposit the ratio of gas to air over particular portions of the surfaces is considerably augmented and the trouble must spread as in the air heater illustrated in Mr. Harlow's paper. Re-circulation of some hot air through the air heater can only be a palliative measure. There is no hot air available during the critical periods when the corrosion starts. Whether scale on the superheater forms a catalyst or not, it has no right to, and need not be there.

In my experience, mild steel does not oxidise at temperatures below 1100 deg. Fah. If much higher superheat temperatures than are now common are required, then the superheater elements must be formed from heat-resisting steel. If there has been any scaling of mild steel superheater elements by high temperature of the metal, with a final mean steam temperature of 850 deg. Fah., it has been caused by unequal distribution of the steam through the elements or by faulty combustion, *i.e.*, imperfect mixing of the volatiles with air, so delaying the completion of the combustion to the superheater space and beyond. H.R. steel does not withstand the action of H_2SO_4, and preheating is just as necessary to prevent corrosion of H.R. steel superheater elements as for mild steel elements, or, if the chemists prefer, to prevent the formation of the catalyst, which causes corrosion in the air heaters.

It is certainly the case that there was very great trouble from corrosion in air heaters when superheat temperatures were much lower than now obtains. There was much air heater trouble in boilers that had no superheaters. It does not matter very much what the correct explanation may be so long as the desired result—the elimination of corrosion—is obtained. I refer your readers to my paper, "Observations on the Development of Combustion Technique," read before the Institute of Marine Engineers on March 10th, 1936.

C. P. PARRY.

Birkenhead, December 2nd.

WELDED JOINTS AND THE IZOD TEST

SIR,—Past and recent papers stressing the dangers of dendritic weld metal deposits, based on the results of Izod tests of such weld metal, have led many people to believe that a large number of small runs, or beads, of welding, each normalising to some extent the under-deposited layers, will produce better welds than are obtained by the use of large electrodes and high currents, resulting in a more dendritic type of weld metal. So general has this dangerous fallacy become that it is time the conclusions arrived at by these various authors were viewed in relation to the strength of the welded joint as a whole, including the heat-affected zone of the parent metal, to withstand the stresses for which it has been designed.

If two types of rope were purchased, one withstanding 10 tons breaking stress and the other 5 tons, and it was found that the 10-ton rope could be cut through with a knife much more easily than the 5-ton one, this would not necessarily be taken as evidence that the 5-ton rope was better than the 10-ton one.

A welded joint on structural work is designed to withstand certain calculated static stresses. In ship work and engine parts the welded joint must, in addition, withstand not only static stresses, but superimposed thereon, fatigue stresses, and often shock loadings. The usual mechanical tests that the designer relies upon for a welded joint to stand up to the designed stresses are:—The so-called ultimate breaking stress of the joint, which is very misleading; the yield point, which may be arrived at by the "drop of the beam" result, or by elongation, extensometer method, which may give varying results and is never very accurate; proof stress; bend tests of the welded joint, which, while giving some indication of the ductility of the joint, do not necessarily prove whether it is the weld that is ductile or the plate, or whether

there is a very hard lamina of heat-affected metal between the weld and the plate that would give poor results under shock or fatigue testing. There is also the all-weld metal test, which is ideal for indicating the ductility of the weld metal itself, but gives no information on the danger zone of the heat-affected part of the plate.

Probably of all the tests, fatigue endurance limit of a welded joint is the best if done with a pulsating type of fatigue testing machine, which stresses the whole of the joint, and not with a rotating type of fatigue machine, which stresses the outside skin of the specimen to a greater extent than the interior. Strange to say, it has been found that the bend test, the hardness of the heat-affected zone in the plate adjacent to the weld, and the fatigue endurance are all improved when large electrodes with heavy current inputs and slow rates of welding speed are adopted.

In the case of certain high-silicon plates from the s.s. "Mauretania," which the writer had welded up and which were tested by the late Professor B. P. Haigh for fatigue endurance, it was found that this 35-ton plate, when welded with 400/500 amperes using large electrodes, had a fatigue endurance of $0 \pm 10{\cdot}3$ tons per square inch, but when the specimens were welded with only 180/220 amperes, using smaller electrodes, the fatigue endurance limit dropped to $0 \pm 9{\cdot}7$ tons per square inch. Even with ordinary 0·2 per cent. carbon steel plate the average fatigue endurance limit at ten million cycles for perfect welds was $0 \pm 11{\cdot}2$ tons per square inch, using 200/250 amperes of current, whereas when using 1200 amperes with the submerged-melt type of machine, a higher endurance limit was reached; in certain cases a figure as high as 0 ± 13 tons per square inch was obtained, and one specimen actually broke in the plate a considerable distance away from the heat-affected zone; all these latter welds were highly dendritic throughout. It is quite a common thing for such weld specimens, 1in. square and more, to be bent, without cracking, over a radius of ½in., and this in spite of the weld being highly dendritic or rather columnar. Such bend tests for mild steel plate cannot be even approached by any type of hand welding. It must be admitted that Izods on such type of dendritic weld will be comparatively low—about 30 foot-pounds to 40 foot-pounds, and occasionally only 25 foot-pounds, as compared with 50 foot-pounds to 75 foot-pounds for welds that have been greatly normalised by using small currents and large numbers of runs, but these latter type of welds will never withstand either the bend test or the fatigue endurance of the former welds.

So far as the remarkable ductility of the submerged-melt, highly dendritic type of weld is concerned, it is probable that the exclusion of the atmosphere from the hot weld metal, resulting in purer weld metal with less oxides, and particularly preventing the formation of nitrogenous pearlite, accounts for this ductility.

The problem which faces the designer is the old one of "The weakest link . . ."; in other words, the heat-affected zone, which invariably has a higher Vickers hardness and is more brittle than either the plate or the weld, is the weakest part of a welded joint, and this problem becomes acute as the carbon content of the plate increases, or alloyed steels are used, with the exception of austenitic steels, and there are only two ways of reducing the hardness in this zone.

If high yield strength must be obtained to meet modern requirements, such, for instance, as gun carriages, where lightness is essential, the Vickers hardness in this embrittled zone can be kept down, first by keeping down the carbon content of the plate and obtaining the strength by adding alloys, and secondly, by using high energy inputs per inch length of welding, because the higher the energy input measured, say, in Joules per inch, the lower will be the hardness in the heat-affected zone, and the larger will be the angle of bend that this particular metal in the heat-affected zone would withstand. Generally, with most alloyed steels of not over 0·25 per cent. carbon a satisfactory hardness in this zone, indicating a satisfactory ductility, can be obtained by using large electrodes, high currents, and slow welding speeds, but in some cases preheating may be necessary in addition. Even with ship quality mild steel plate it will be found that for a butt joint in ⅜in. plate, made at 72 deg. Fah., with $\frac{3}{16}$in. covered electrodes, using 6900 watts, and a welding speed of 11·9in. per minute, the Vickers hardness in the heat-affected zone would be 310, and the angle of bend of the slow notch bend test would be only about 12 deg., whereas if 8200 watts had been used, and a welding speed of 7·16in. per minute, giving 68,700 Joules per inch, as compared with 34,800 for the former case, the Vickers hardness would only be 250 and the angle of bend approximately 20 deg. Here it can be stated that a Vickers hardness of over 325 in the heat-affected zone indicates a brittleness which gives a bad joint if this brittleness is due to martensite. Post-heating of the work to alter the martensite to bainite gives a less brittle structure.

Enough has been said to indicate the fallacy of coming to conclusions on the strength of a welded joint merely on Izod tests, which, after all, are tests which give an indication of what happens long after plastic flow has taken place in the metal at the bottom of the Izod vee, even after the ultimate tensile strength has been passed and a crack has been formed, and merely gives information of the orientation and size of the crystal structure to prevent propagation of the crack through the metal. While it is important that reasonable Izod figures should be obtained, it must be realised that Izod results give no indication of the ductility of a welded joint, nor necessarily of its fatigue endurance or yield point, and a designer is more concerned with the ability of a welded joint to withstand, with an ample margin of safety, the stresses he assumes will be imposed upon the joint, than he is in knowing what the behaviour of the joint would be after parts of it had been stressed beyond its ultimate strength, and a crack had been formed.

H. B. FERGUSON, M.I. Mech. E.,
Director, G. A. Harvey and Co.
(London), Ltd.

London, December 9th.

CO-ORDINATION OF TECHNICAL SOCIETIES

SIR,—I have read the letter from Mr. A. W. Crampton, in your issue of the 3rd inst., with considerable interest, for this is a matter with which my Association and myself personally have been greatly concerned in recent years. No one, I think, will question your correspondent's view that, in many directions, there are too many associations and societies, or that, in the case of engineering, there is probably scope for a greater number and variety than in other spheres of technical activity.

Speaking for the architectural and allied professions—surveyors, &c.—I cannot, however, accept his contention that there is no need for several architectural bodies, and that "fusion seems to be the obvious principle." He is surely wrong in his implication that the architectural is a perfectly definite and homogeneous professional field. It may not have the wide range and variety of engineering, but it is certainly diverse and anything but homogeneous, especially if one includes surveyors and other allied interests.

From a thorough knowledge of the position, extending over a quarter of a century, it is my firm belief that, so far from a superfluity of associations in the architectural and allied world, those professions have been extremely moderate and restrained in the urge towards corporate creations. As a matter of fact, there are only three recognised under the Architects Registration Acts, 1931–38, of which this Association is one, and only two of them, including ourselves, admit both architects and surveyors within their membership.

One must not, moreover, overlook the fact that a little healthy rivalry in these matters is all to the good. For one profession or group of related professions to be represented by one body only would constitute a probably undesirable monopoly not in the best interests of those technical groups. I quite agree, however, there are two sides to this matter.

If I may add a word on behalf of my own Association, I should say that we have much more than justified our existence, as is evidenced by a rapidly growing membership; and, at the same time, our relations with other bodies in the same professional group are of a friendly and mutually helpful nature.

I might mention also that we were among the first to recognise the urgent need for closer collaboration between architect and engineer, and the best form or forms of that collaboration have been our constant study. There appears to be a real need of some central or federated organisation to combine the interests of engineers, surveyors, and architects.

G. B. J. ATHOE,
Secretary, Incorporated Association
of Architects and Surveyors.
75, Eaton Place, S.W.1,
December 10th.

FOREMEN PANELS

SIR,—After more than four years of war, one of the Ministries apparently wishes to recognise the splendid work and devotion to duty displayed by foremen in engineering works. Up to date, this class of worker has received little consideration, and yet I doubt if any responsible engineer will not concede that they are the backbone of any works. They have had to train unskilled labour, bring it to a very high state of efficiency; they have had to up-grade men and teach them to take over added responsibilities; and have also had the difficult task of turning over from their usual work to war jobs; and, further, have had to see that their plant was maintained properly whilst suffering from a shortage of skilled labour for this purpose.

I understand it has now been suggested by at least one Joint Production Committee of the M.O.P. that foremen's panels be formed with a view to arranging a visit now and again to local works of interest to foremen. Surely such a meagre suggestion is not worthy of men who have done so much and been recognised so little.

It seems to me that this is the appropriate time to give the foremen that status which they deserve, and anything organised for them should be carried out with higher intentions, both with regard to social amenities and intellectual welfare.

The present-day foreman would be an asset to our large and important engineering institutions. Am I too bold in suggesting that they might form a foreman's Section? It would comprise men of very considerable workshop experience and yet whose technical knowledge would not qualify them for associate membership. It is highly conceivable that with this encouragement many a foreman would make a real effort to acquire the necessary knowledge to pass the higher examinations.

There are many fairly young foremen to-day quite capable of passing the examinations if they had to apply themselves to that end, and in the meanwhile there would be a still closer

connection between those responsible for most of the practical work, and the others who undertake the development of new designs. It is not unknown for foremen to-day to be of great assistance to production engineers.

Another point worthy of consideration :—The great technical colleges throughout the country have complained in the past because their students did not derive the full benefit of the occasional training they got in works during their long vacation. The arrangements are usually agreed between the technical college authorities and the employers. Surely the weakness of the scheme as it operates to-day is that there is not that co-operation between the foremen and the students, which is desirable.

It is all very well for the employers and the college authorities to decide matters, but I do not see how any such schemes can be successful until the foremen enter into the schemes somewhere or somehow. It would be both a nice and advantageous gesture on the part of the colleges if the foremen were invited to inspect the training facilities at the institutes, and short addresses given by the professors explaining their methods of training, and the desirability of students entering works during the vacation. The foremen would then feel themselves part of the scheme, and would respond. It would develop that state of mind between the educational authorities and the foremen which could not help but be of mutual advantage, and, incidentally, the foremen might teach the professors a little about the students they have been asked to assist.

If the Regional Joint Production Committees are definitely forming foremen's panels, the organisation should be good and very thorough. There need not be many meetings each year, but those arranged should be of very high quality, otherwise meetings may tend to develop into just "pleasant outings." The best foremen neither ask for nor would tolerate this. They appreciate good lectures by recognised authorities, and they would enter whole-heartedly into any worth-while debate.

I have not mentioned such matters as the raising of the school-leaving age, sandwiched training, and such-like important matters, all effecting the efficient running and planning of the workshop, and consequently affecting the foreman. He, too, should have an opportunity of expressing his views on such important matters, and they will be worth hearing. He must be encouraged to feel he is part of the scheme, for he can give much help and smooth out many difficulties. The same remarks apply to all schemes involving legislation for the betterment of factory conditions, payment by results, and all such-like matters, in which the foreman plays one of the most important parts.

It is impossible in a letter to develop a complete scheme, and one must differentiate between large and small works, but the fundamental principle underlying what I have tried to express is that any panel formed for foremen should be such as to raise their status, and be an expression of appreciation for their unselfish services.

FRANK E. WALKER.

Stevenage, Herts, December 11th.

PIECEWORK AND PAYMENT BY THE HOUR

SIR,—The extremely interesting arguments on the subject of piecework and payment by the hour advanced by Lord Perry in your issue of November 12th are, I venture to suggest, based on two fallacies. First, all men's requirements are by no means equal, and, secondly, men persist in remaining individuals, and however convenient it might be from an employer's point of view to regard them as automatons, the fact remains that no two human beings are alike and any system which does not take into account their essentially human differences is bound to run into trouble.

The requirements and outlook of a single man are obviously very different from those of a married man with perhaps his parents to look after as well as his own family, and the automaton theory approaches rather too closely to Fascism and all that is implied thereby for democratic nations to accept.

The present system or systems of wages in the engineering industry have been built up over many years by free negotiation between the unions and the employers' federations, and their very diversity and seeming complexity enable them to cater for all types of individuals and firms. In normal times, with no Essential Works Order, the man who wants safety first and does not object to monotony coupled with a steady wage would tend to gravitate to, say, Lord Perry's company (or possibly the Civil Service).

The man to whom high wages appeal above all else wants piecework and the individual opportunities of personal gain by personal effort and ingenuity which it offers.

Last, but by no means least, especially in British engineering, is the real craftsman. Like the true artist which he is, he expresses his individuality by the work he does. His place is on the jig borer or in the tool-room, where he is assured of a steady wage on a daywork basis according to his trade and where he is allowed time to satisfy his own exacting standards of quality on every job he does.

To condemn systems of piecework, payment by results, and the like because in the present highly abnormal conditions they have produced some highly abnormal inconsistencies is surely to let go the substance of years of experience while grasping at the shadow of theory based on the false premise that all men are equal.

It is certainly true that after the war there will be a great deal of sorting out of piecework tangles to be done, and no doubt it will be found that piecework has been wrongly applied to various classes of work under the stress of war conditions and the wartime demands of production, and still more production, at any price.

But when all is said and done, the differences between human individuals will always remain, and a successful system based on human endeavour should never fail to allow for such differences. Therefore I advocate the utmost flexibility in fixing the system of payment for various types of work, adapting the method to the circumstances within the broad limits laid down by negotiation between the federation and the unions. On this firm foundation it should be possible to build a post-war wages structure in the engineering industry within which can be solved many of those human problems which our super-planners are sometimes inclined to overlook.

JOSEPH ADAMSON.

Hyde, December 10th.

SIR,—It is rather a pity your correspondents do not make particular reference to the class of work they have had experience of, as this, I think, detracts from the value of their views. In the engineering shop, particularly where repetition work is carried on, piecework or daywork can easily be arranged, and, if on a proper basis, to the satisfaction of the employer and the workpeople.

In other classes of work a suitable arrangement is not quite so easy, but after a very lengthy experience in foundry work, I am entirely in favour of collective piecework as the best incentive for a man to work to the best of his ability for a just reward. If all men were honest and worked for work's sake, then there would be nothing wrong with ordinary daywork, but unfortunately employers know that this state of affairs does not exist.

The base rate for dayworkers is fixed not on the capacity of the best workman, but rather on the poorest worker in the shop, and whether an honest day's work is done or not, the full rate of payment is made, whereas on a piecework system there is full scope for the activities of any man, and, strangely enough, the shop steward or the chargehand is the first to point out any men who are shirkers or not "pulling their weight."

Any reasonable system of piecework based on fair lines is bound to be to the advantage of the worker and the employer, as well as being a great stimulus to increased output.

PARKER FOUNDRY (1929), LTD.,
T. MCLEAN,
Managing Director.

Derby, December 13th.

SIR,—I have read with great interest the article by Lord Perry in your issue of November 12th.

The success of plain timework in the great Ford organisation is well known, and it may well be that it could be applied with the same results in other industrial units ; but if it is to be applied, it should be as the result of negotiation and agreement. It must be remembered that the overwhelming majority of industrial units have less than 100 employees, and these units are unwise to take independent action in such matters.

The idea that discussion with trades union officials means that there will be interference with the employer's business must be got rid of.

No one has expressed the right line better than Sir George Nelson, President of the F.B.I., who has said that if industrialists are to build a rampart for the defence of industry they must have labour and the trades unions with them on the same side of the rampart, not the opposite side.

DUDLEY GORDON.

Dartford, December 13th.

OIL ENGINE OUTPUTS

SIR,—*Re* the correspondence on power of oil engines, the correspondent commenting on the Dendy Marshall formula and giving exhaust temperatures should give the divisor to be used with the Dendy Marshall formula for each temperature, otherwise the power cannot be obtained.

I wonder what Mr. Dendy Marshall means by a double-acting oil engine for which his formula is to be used. A real double-acting oil engine is seldom seen.

ARTHUR F. WOODCOCK.

Leicester, December 11th.

NEW METHOD OF SORTING STEEL

SIR,—With reference to the article "A New Method of Sorting Steels," which appeared in your issue of December 3rd, 1943, I would like to say that I was personally responsible for the development and research on the Kinsley system of magnetic testing of iron and steel products some ten to twelve years ago.

This system was installed by D. Napier and Son, Ltd., and was described in an article which appeared in *The Industrial World* about June, 1932. The apparatus was capable of investigating any testing problem or could be split up to handle single problems in more convenient form. It was also successfully used for the problem mentioned in the present article to segregate valve springs which had received different heat treatment.

The use of either an oscillograph or cathode ray was eliminated in the Kinsley system, but it was most disappointing to find that numerous cases of steels having different physical and chemical characteristics produced exactly similar wave shapes in the electrical circuit up to as far as the fifth harmonic. Higher harmonics were found to have too small an ampli-

tude for practical purposes. For this latter reason further work on the Kinsley system was stopped by myself and associates.

I await further details of future research by Messrs. Brown and Bridle with interest, and should be pleased to let them have the benefit of any of my experience on this subject, should they so desire. KINMAG.

December 13th.

Technical Education

ON December 1st the Council of the City and Guilds of London Institute submitted to the Board of Education the following statement of its views on matters relating to higher technical education.

It is disappointing to find from their White Paper that the Board of Education do not promise plans for the urgent post-war development of all branches of technical education.

The needs of industrial rehabilitation and progress call for the provision by the State of facilities for a much larger number of students at the universities or at technology colleges of university rank established by the State, not only to meet the prospective demand, but to supply the still greater potential requirements of industry in the national interests.

In these technology colleges it is important that a broad basic education in science and other subjects should receive first consideration, so that they can rank educationally as high as universities. This calls for special care in the selection of staff, as referred to below.

These technology colleges should be distributed so as to be linked with specialised branches of industry, associated with different districts, and their individual provision for advanced and post-graduate study and research should be planned accordingly.

Apart from the establishment of some new university-rank technical colleges, it may be possible to reorientate or up-grade some existing institutions for this purpose. These should confine their curricula to the higher grade education and research, so as to ensure that the teaching staff and the students are maintained at the requisite level.

At the universities care should be taken not to destroy the freedom of the institution and of the individual to undertake the most abstruse studies and research. All students, however, should be given the opportunity, but not be compelled, to broaden their outlook by contact with industry before or during the university course.

The immediate post-war opportunity should be seized to secure for the teaching staff, particularly for the technical colleges, but also for the science departments of the universities, men who are science graduates of the highest qualifications, but who have, by national service during the war or otherwise, been brought intimately into contact with the industrial outlook and needs. This will inevitably call for a new scale of salaries.

To avoid any undue "inbreeding" in the universities, every effort should be made to encourage the inter-university circulation of students and research workers, both inside the country and overseas, which experience has shown to have such a broadening influence. In the olden days practically all German university students studied at two or three universities before graduation, and it was usual for most British graduates in science and many in other branches of learning, who desired to continue their studies, to go abroad to a German or French university. Nowadays the attraction of the Ph.D. degree frequently keeps students for six or more years continuously at a single university.

The extension and development of the highest grade studies in management and leadership at the university level should be encouraged, but here, again, not specialised at too early a stage. In particular, the opportunities for teaching and practice in industrial psychology (motion study, &c.) deserve more attention in this country.

A closer linking of universities and technical colleges of university rank with research associations and Government and industrial research departments should be fostered. A triple advantage is anticipated. First, a fuller provision for and utilisation by the educational institutions of expensive equipment, both internal and extra-mural. Secondly, the encouragement which it should give to the recruitment by industry of students from these institutions. Thirdly, it would encourage the State to undertake long-range and fundamental research, which is so essential for our industries if we are to possess national initiative in the development of new products and new processes, instead of paying tribute to other countries by importing, or utilising under royalty, their discoveries and inventions.

Imaginative planning of any new technical colleges is called for. Since the pace of advance in technology is so rapid, buildings and equipment soon get out of date. It is desirable therefore to avoid blindly copying any American or Continental models, and to limit specialised equipment, so far as possible, to model plant to demonstrate technical principles. The advantages of utilising temporary buildings, replaceable ten years or so ahead to meet new requirements, should be considered. This would favour the prompt action which is required so that ex-Servicemen can be trained immediately post-war for industrial recruitment.

British industry will depend in the future even more than in the past on the creative ability not only of our scientists and technologists, but also of our designers. The importance of linking up the æsthetic and scientific outlook in industry cannot be too much emphasised. This calls for action in the field of higher education so that colleges of art and their students can be adequately supported and brought into much closer touch with technological colleges.

There is a need for more information on technical and university education in other countries. The Board of Education's "Educational Pamphlets" have occasionally contributed information of this type, but their frequency and scope should be extended. At present we are almost entirely dependent on what is learnt from visits by private individuals. In particular, although the universities are outside the control of the Board of Education, there is no reason why foreign experience in this field should not be reviewed by the Board. Where can we find, for example, particulars of the "M.I.T.," "Cal. Tech.," Harvard post-graduate School of Business Administration, and other outstanding American and Continental, and now especially Russian, examples of higher education? Information of this character to be of real value should be provided by men experienced both in the educational and in the industrial structure of the country visited as well as of Britain.

A survey should be made of the existing and potential accommodation for largely increased numbers of students in the universities and technical colleges, particular attention being given to the possibility of some departments being less congested than others, and to the questions of staff and equipment available or required.

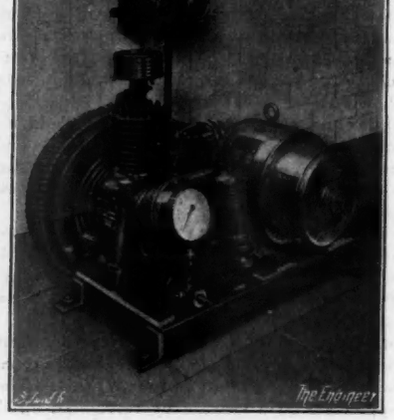
Some assessment of the potential future requirements of industry for university and technical college graduates, in comparison with other countries, is called for.

For many of these problems, and particularly for the suggested inquiries, the staff of the Board of Education could with advantage be guided by advisory committees on which progressive industrialists should be invited to serve.

Small Compressed Air Unit

AMONG the special applications of compressed air which have been developed since the outbreak of war by the Heywood Compressor Company, Ltd., of Redditch, is one which was developed to meet an Admiralty requirement. This equipment, illustrated below, comprises a compact motor-driven compressor set with automatic pressure regulator and oil and water trap. The whole equipment occupies a floor space of only 28in. by 18in., while the overall height is 21½in. The compressor is an air-cooled, single-cylinder, two-stage machine, belt driven at 500 r.p.m., from a 1½ H.P., 110 volts D.C. motor. At this speed the compressor has an output of 3 cubic feet per minute against 100 lb. per square inch pressure. The compressor cooling is assisted by a fan pulley.

An interesting feature of the set is the oil and water trap. After compression, the air passes through a spiral cooler and is then directed into the trap. By means of jets inside the trap the air is projected at high speed against the inner wall of the inlet chute. A large proportion of the condensed moisture is thus separated mechanically and falls to the bottom of the trap. The space inside the trap reduces the air speed and provides further opportunity for moisture and oil to be separated. The moisture and oil are collected at the bottom of the trap, and can be drained off at intervals. The moisture-free air is filtered when passing through the outlet connection, so that dry and clean air is delivered to the services.



COMPRESSED AIR UNIT

The automatic pressure regulator is mounted on the back of the bracket which also carries the air pressure gauge and the oil and water trap. The function of the automatic pressure regulator is to permit the compressor to charge the external air system to any desired pressure between 90 lb. and 130 lb. per square inch, and then to "cut out" so that the compressor delivery is diverted freely to atmosphere. This off-loads the compressor and reduces the load on the electric motor. With adequate cooling the compressor is capable of pumping against pressures up to 600 lb. per square inch.

WAGON SHORTAGE AND COAL PRODUCTION.—Speaking in the House of Commons on Tuesday, November 30th, Major Lloyd George, the Minister of Fuel and Power, said that he had been kept fully informed of the losses of coal production which had, unfortunately, occurred through shortage of railway wagons, chiefly in the North-East and North Midland Regions. Up to the week ended November 20th, some 66,000 tons had been lost from this cause, and wagon shortages have also been experienced at open-cast workings. He was in the closest touch with the Minister of War Transport on this matter. According to the latest available figures, 5·37 per cent. of the total pool of railway-owned and privately-owned requisitioned wagons were under and awaiting repairs at the end of last month. Between the week ended July 3rd and the week ended November 13th, 1943, there were reported to his Ministry 421 stoppages due to disputes. The aggregate loss of output from all stoppages during that period was estimated at 562,000 tons. All of these stoppages were unofficial and took place against the advice of the Mineworkers' Union.

A Survey of Plastics*

By S. LIVINGSTON SMITH, D.Sc. (Eng.), M.I. Mech. E.†

I.—Introduction

The term "plastics" is loosely applied to a wide collection of industrial products; some of them are entirely synthetic and some are modified natural products of long standing. These products can be easily formed to shape at some stage in their manufacture, but finally become rigid products which may be the very reverse of "plastic" as the term is understood by an engineer. The current usage of the term appears to be confined to materials made from synthetic or semi-synthetic organic compounds of a resinous nature, which are used either alone or more generally modified by plasticisers, fillers, reinforcements, dyes, &c. The rubbers, natural and synthetic, and glasses are usually excluded from this class, although, chemically, the dividing line is not well defined.

From the point of view of the chemist, the resinous component is the more important, but the engineer is more interested in the finished composite material and it is this aspect which will be stressed in this paper. It will be generally conceded, however, that some knowledge of the structure and properties of the components is necessary in order to make the most efficient use of the composite, and this aspect of the subject is best studied against the background of macromolecular chemistry.

The characteristic property of resinous compounds is that they can be formed into films, fibres, &c., and it has been shown that this is associated with molecular weights of thousands as compared with the tens and hundreds met with in classical chemistry. These large molecules, known as macromolecules, are obtained by arrangement of atoms in chains. The mechanism by which synthetic macromolecules are formed has been described as either "polymerisation" or "condensation." With the latter, some simple substance, *e.g.*, water, is split off and eliminated, whereas chain formation by polymerisation occurs by opening of double bonds.

The properties of the product are determined by the chemical nature of the units in the chain, the length orientation and flexibility of the chain, the nature of any side groups, and the effect of forces between the chains. The forces between the chains may vary from primary valency bonds to the weakest of secondary forces. These secondary forces, known as van der Waal's forces, may be strong or weak, depending on the nature of the atoms or groups. For example, forces between polar groups are stronger than those between non-polar groups.

In the case of phenol-formaldehyde, the basis of bakelite, primary cross-bonding is so extensive that it is impossible to distinguish a main chain. The resulting molecule is probably spherical, containing a completely random arrangement of atoms.

The existence of a relatively small number of primary links may have an important effect on physical and chemical properties. Thus, if a substantially linear molecule is cross-linked to the extent of 1 in 1000, solubility is decreased considerably. When the cross links are individually weak and all secondary links are much weaker than primary, then the number of links becomes more important. The number of links per chain will clearly depend on the length and orientation of the chains. The more highly orientated the chains, the stronger is the aggregate bond resulting from a number of weak bonds. Another factor of importance is the flexibility of the chains. Normally, free rotation is possible around a single carbon-to-carbon bond, but this freedom may be reduced by double bonds in the chain and certain substituents. It has been found that "rubber-like elasticity" requires high internal flexibility.

Summarising, the properties of macromolecules can be predicted to some extent from a knowledge of the chemical nature of the units in the chain and of the mutual interaction between chains, depending on length, orientation, and flexibility.

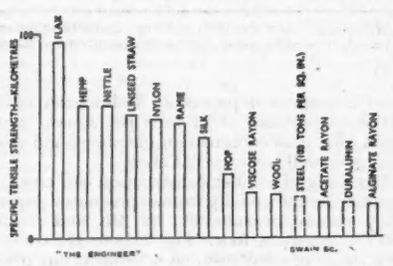
The reaction to temperature of synthetic resins provides the basis for a generally accepted division of plastics into two classes, thermo-plastic and thermo-setting. A thermo-plastic resin is one in which softening with rising temperature is a reversible process, *i.e.*, a product hardens on cooling, but may be softened by heating an indefinite number of times. A thermo-setting material is one which is changed by the application of heat to a product which cannot subsequently be softened by heating.

II.—Survey of Plastic Products

The range of plastic products arising from the combination of different resins with fillers in different processes is wide. There is an almost infinite number of possible combinations of resin and filler, and it will not be possible to deal with them all in a relatively short paper. Consequently the field will be intentionally restricted to certain of the more important products under the following headings:—

(1) *Unfilled Resins.*—Fig. 1 shows the specific tensile strength of some of the more common resins in comparison with steel and duralumin. It will be understood that resins are seldom used unfilled where strength is the main requirement.

(2) *Moulding Powders.*—A substantial part of the plastics industry in this country is based on moulding powders and consequently machining for this purpose is very widely distributed. A large proportion of the moulding powders used are of the thermosetting type.



Specific strength in kilometres = 1·57 × strength in tons per square inch ÷ density in grammes per cubic centimetre

FIG. 1—*Specific Tensile Strengths of Unfilled Resins*

Partly condensed resin in solution or powder form is mixed with the filler such as wood flour, chopped fabric, or asbestos. The condensation of the resin is then advanced, either by hot rolling or oven drying until a stage is reached which will ensure the required flow being obtained during the subsequent moulding process. After this part condensation the powder is ground down and is sold to moulders, who complete the production of the article by placing the moulding powder into steel moulds, wherein it is heated to a temperature of 160 deg. to 180 deg. Cent. under a pressure of the order of 1 ton per square inch. This completes the condensation of the resin which now becomes set and will not soften on further heating.

Mouldings made from powders have no great strength (modulus of rupture about 3 tons per square inch) and are inherently brittle. However, special shockproof mouldings may be made from powders containing long fibres of either wood pulp or rag.

The outstanding advantage of moulding powders is the extreme ease of production of mouldings which are made to close dimensional tolerances in one operation. As compared with metals, mouldings are extremely light; they do not corrode, and are electrical insulators. It is thus possible that engineers will be able to use mouldings in many instances where they previously used metal castings, with a resulting saving in weight and machining, but no real application exists where strength is an important factor.

(3) *Laminated Sheet.*—Whereas, when judged on a basis of specific tensile strength, the available resins when used alone do not compare with high-tensile steel or aluminium alloy, cellulose fibres may have a specific strength four or five times that of the metals and their incorporation in a plastic may produce a material of great strength. In laminated sheet the cellulose fibres may be included in the form of papers or fabrics. Such papers or fabrics are impregnated with alcoholic or aqueous solutions of resin, dried in continuous ovens and pressed in multiple daylight presses with steam-heated platens at a temperature of about 140 deg. Cent. Laminated sheet was originally prepared with good electrical properties as the major objective and the tensile strength at present called for in British Standard Specification No. 547, which relates to paper base sheet, is only 3·6 tons per square inch, and British Standard Specification No. 972 specifies three grades of fabric sheet calling for tensile strengths of 6·3, 4·7, and 4 tons per square inch respectively.

(a) *Paper-Base Laminated Sheet.*—About four years ago the attention of the author was drawn to the possibility of using reinforced plastic materials for structural, as distinct from electrical, purposes; and an investigation was commenced at Teddington to study the fundamental considerations governing the strength and stiffness of reinforced plastics. The major part of this work has dealt with paper-base laminated sheet.

Summarising, it may now be stated that the best combination of mechanical properties results from a board having maximum density. This is attained when the amount of resin present is just sufficient to fill all the voids in the paper. It is also clear that the main function of pressure is to reduce the amount of voids in the paper and therefore, if low pressure (250 lb. per square inch) is to be used, the impregnated sheets before pressing must have a high density, *i.e.*, a small percentage of voids. Otherwise, high resin content will be needed to effect complete bonding, and boards with low tensile strength and stiffness will result. It is also clear that the resin must have sufficient fluidity, under the selected conditions of pressure and temperature, to fill the air spaces.

Impregnated sheets containing only a small percentage of voids may be obtained by two methods: (1) The paper may be made so that it has a high apparent density; and (ii) voids may be removed from the impregnated sheets prior to the pressing operation by the process known as "super-calendering."

The properties of a typical board pressed at 2000 lb. per square inch, the pressure normally used in industry, are given in Table I. This board contains the optimum resin content.

TABLE I.—*Mechanical Properties of a Board Made with High-Density Kraft Paper*

This paper is impregnated with 21 per cent. aqueous phenol formaldehyde resin and pressed at 2000 lb. per square inch.

Density, grammes per cubic centimetre...	1·47
Tensile strength, tons per square inch:	
Machine direction...	16·5
Cross-wire direction	10·7
Mean	13·6
Shear strength, tons per square inch:	
Perpendicular to laminations	7·5
Parallel to laminations	2·0
Parallel to edge of sheet	7·8
Compressive strength, tons per square inch	11·5
Young's modulus (pounds per square inch):	
Mean of two directions	$2·1 \times 10^6$

Table II gives the mechanical properties of a board made with the same paper, but pressed at about one-tenth the pressure. In order to fill the voids completely the resin content is increased to 37 per cent.

TABLE II.—*Mechanical Properties of a Board Made with High-Density Kraft Paper*

This paper is impregnated with 37 per cent. aqueous phenol formaldehyde resin and pressed at 225 lb. per square inch.

Density, grammes per cubic centimetre ...	1·42
Tensile strength, tons per square inch:	
Machine direction...	12·7
Cross-wire direction	8·5
Mean	10·6
Shear strength parallel to laminations, tons per square inch	2·4
Compressive strength, tons per square inch...	11·9

It will be seen that, whereas the tensile

* Institution of Mechnical Engineers, December 10th. Abstract.

† Superintetdent, Engineering Department, Nat'onal Physical Laboratory.

strength is lower, the shear and compressive strengths in a direction parallel to the laminations are not inferior to those of boards pressed at the higher pressure. There is also a very great improvement in the strength of these boards in comparison with that called for in the specification mentioned earlier; and the foregoing serves as an example of the importance to the mechanical engineer of research on plastic material from the mechanical, as distinct from the electrical, point of view.

(*b*) *Fabric-Base Laminated Sheet.*—Laminated sheet prepared from fabric, although more expensive and somewhat less strong than that prepared from impregnated paper, is often used in preference to the latter because of its reputed greater resistance to shock.

In 1939 tests on the products of various makers were carried out at the National Physical Laboratory under the direction of the author, and Table III gives some idea of the materials then available.

TABLE III.—*Strengths of Fabric-Base Laminated Sheet*

Material.	Tensile, tons per square inch.			Compression, tons per square inch.	Shear, tons per square inch.	Young's modulus, 0 deg., lb. × 10^6.	Shear modulus, lb. × 10^6.
	0 deg.*	90 deg.	Prolonged loading, 0 deg.				
High-grade cotton fabric (uncrossed)	9·55	6·85	7·10	9·80	3·15	1·46	0·45
Cotton fabric (crossed)	8·12	7·74	6·66	9·60	3·15	1·38	0·33
Low-grade cotton fabric	6·47	7·10	4·70	8·86	2·56	0·97	0·33
Cotton fabric	6·40	6·74	4·68	9·89	3·10	1·08	0·31
Cotton fabric	5·04	5·33	3·85	11·52	2·56	0·90	0·34

* A reference direction, generally parallel with the warp of the fabric, is referred to as 0 deg., and 90 deg. refers to a direction in the plane of the sheet at right angles thereto. A crossed board is one where the alternate fabric laminations are turned through a right angle.

Table IV shows the strengths of the various components of a fabric-base board. The strength of the board is a function of the fabic, but its stiffness as indicated by the two moduli is little greater than that of the resin. The failure of the fibres to contribute much to the stiffness appears to be due to the effect of crimp and twist in the fabric. This suggests a direction for further research on the improvement of

TABLE IV.—*Results of Tests on Component Parts of a Fabric-Base Laminated Board*

	Density, grammes per cu. cm.	Specific tensile strength, kiloms.	Specific moduli, kiloms.	
			Young's	Rigidity.
Pure resin	1·19	2·32	370	140
Untreated fabric	0·596	7·00	115	<5
Impregnated fabric	0·762	5·48	235	<31
Finished product	1·35	5·50	500	177

strength and stiffness of fabric-base boards to bring these properties up to the values such as quoted for paper-base materials in Table I.

(*c*) *Use of Laminated Sheet.*—Laminated sheet is of considerable interest to engineers, since it is readily obtainable in a wide range of thicknesses, machines easily, and is strong enough in relation to its weight to be considered as a stress-carrying material. Due to its properties as an electrical insulator, however, the majority of applications have been electrical but its lightness renders it suitable for

TABLE V.—*Extract from British Standard Specification No. 436, 1940, Showing Permissible Stress Factors of Various Gear Materials*

	Surface stress factor.		Bending stress factor.
Laminated fabric	560	...	4,500
Cast iron (high-grade, heat-treated)	2,000	...	10,400
Phosphor-bronze, centrifugally cast	1,000	...	10,000
0·15 per cent. carbon case-hardened forged steel	9,000	...	20,000
High nickel-chromium case-hardened steel	12 600	...	50,000

mechanical purposes where its cost (2s. 6d. to 7s. 6d. per pound) is not prohibitive.

One application which will be of interest to mechanical engineers is that of gearing where the elimination of noise is important. Unfortunately, only low stresses (see Table V) are permissible, with consequent increase in bulk; and this precludes the use of plastic gears in confined spaces. Research on the improvement of laminated sheet would be worth while in this connection.

One important use of plastic gears is in camshaft timing of internal combustion engines, where the mating gear is either steel or cast iron. With such a combination the noise emitted is stated to be of lower frequency and less audible than with a pair of steel or cast iron gears. Another advantage is the high resilience of the fabric material which gives improved resistance to shock loading such as arises from crankshaft oscillations. In order to allow for the greater elastic deflection of this material as compared with that of steel, it is necessary to modify the tooth form, *e.g.*, tip relief, in order to prevent the teeth of the metal pinion cutting into the face of the teeth of the fabric pinion when entering into engagement.

Laminated plastic is not necessarily confined to flat sheet, but tubes and structural shapes can be made from impregnated paper or fabric. Experimental moulded joists sections made from impregnated papers at Teddington have withstood stresses of 11 tons per square inch when loaded as compression members, and this compares well with the flat sheet.

Panelling of cellular construction can now be produced commercially from impregnated paper. Such panels measure 8ft. by 4ft. and weigh 2·7 lb. per square foot. Fig. 2 shows the results of a range of strut tests on specimens cut from these panels; the failing loads are quite high. Bend test in the longitudinal direction gave a modulus of rupture of 8·3 tons per square inch.

Where the nature of the impregnated paper is such as to require moulding pressures of

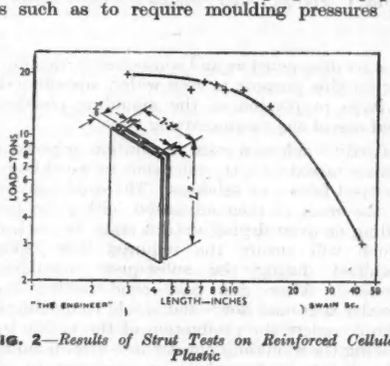


FIG. 2—*Results of Strut Tests on Reinforced Cellular Plastic*

2000 lb. per square inch, the possibilities of moulding sections in laminated sheet are restricted to simple shapes, but where papers suitable for moulding at low pressures are available, more complicated shapes may be considered in conjunction with autoclave processes.

(To be continued)

Sixty Years Ago

SHIPPING DISASTERS

DURING the year 1881–82 there were 3660 shipping disasters immediately around and on the coasts of the United Kingdom, involving the loss of 1097 lives. This total included all forms of maritime accidents, such as wrecks resulting in total loss, partial loss, collisions, and so forth. The number of cases of total loss in the total was 606 and the number of mishaps attended by loss of life amounted to 235. Mr. Joseph Chamberlain, President of the Board of Trade, was determined to reduce the annual list of casualties to ships. He proceeded on the assumption that very few ships would be lost if only men did their duty all round. In a leading article in our issue of December 21st, 1883, we crossed swords with him and argued that shipwrecks were not preventible in any full sense of the term by legal means. The history of ships, we said, was a history of disaster. No amount of legislation would eliminate the annual toll of the Goodwin Sands. A ship caught on them or to windward of them by a heavy gale had small chance of surviving safely whatever Government rules and regulations might be imposed on her construction and operation. The same remark was true of the whole of our east coast. There the provision of new harbours of refuge would be much more effective in preventing the loss of ships than legislation governing their design and management. It was true, we admitted, that suitable legislation might reduce the number of cases of ships foundering at sea or disappearing on their voyages without trace. But such cases formed a relatively small percentage of the total number of marine casualties occurring each year. The great bulk of the losses took place on or around our coasts, and no amount of legislation, it seemed to us, would prevent them.

Improved American Aircraft Armament

IT was announced by the United States Army Air Force Headquarters on Wednesday, December 8th, that alterations have been made to American "Flying Fortresses" and "Liberators," with the object of increasing their offensive and defensive powers. As regards bomb-carrying capacity, all "Fortresses" are now able to carry an extra 1000 lb. bomb load in racks which have been fitted under the wings. The defensive and offensive power has been increased by adding a chin turret with a greater angle of fire and having a more positive sighting mechanism. The turret, which is directly under the nose of the machine, is electrically operated, and is worked by the bombardier, the ammunition being delivered to the guns by means of a roller belt mechanism. The additional turret now gives the "Fortress" no less than four pairs of 0·50 calibre machine guns, mounted in the chin, upper and ball turrets, while, in addition, there are single-mounted guns in the nose and waist and near the radio operator. The "Liberator" bombers have also been equipped with two new power-operated turrets, in the nose and amidships, which, added to the tail and upper turrets, make with the modified armament, four power-operated turrets. Protection for the gunner in the nose of the machine includes a ¼in. belt of armour plate and a glass screen of armoured glass of a thickness of 2½in., which is designed to be bulletproof.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

RUBBER AND INSERTION JOINTING FOR FLANGE JOINTS

No. 945. This war emergency revision of B.S. 945, Rubber and Insertion Jointing for Flange and Similar Joints, has been made necessary by the urgent need to conserve rubber and supersedes B.S. 945—1941. Certain relaxations in the quality of rubber have been made and the specification is restricted to three types—soft, medium, and hard—in place of the five types covered by the earlier edition. The specification is more comprehensive in one respect, in that it has been extended to cover insertion and sheeting used for high and low-pressure steam as well as for water pressure at normal atmospheric temperatures to which the original specification was confined. Price 2s. post free.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Shipbuilding in Canada and Sweden

During the twenty years before the war Canada did not build one sea-going merchant ship, states *Foreign Commerce Weekly*, the organ of the United States Department of Commerce. By mid-August, 1943, however, a total of 200 freighters had been launched, the two-hundredth ship establishing two records. It was completed thirty-nine days after its keel was laid and its hull was constructed in thirty working days. Freighters delivered, under construction, or on order total more than 300, of which 90 per cent. are 10,000-ton ships. Roughly, half of the overall commitments for shipbuilding in Canada, which total 1000 million dollars, will be spent on cargo ship construction. More than 1,500,000 tons of merchant shipping has been delivered. There are 50,000 workers in the eleven Canadian yards engaged on the cargo ship programme. Arrangements are being made to build next year a cargo ship of improved design to be known as the "Canadian" type. One of the characteristics of the ship will be its adaptability for either coal or fuel oil. *Foreign Commerce Weekly* also records that the all-welded cargo motorship "Krageholm," of 6500 deadweight tons, recently launched in Sweden, has refrigerated holds for fruit and has accommodation for eight passengers. A speed of 16½ knots is expected from the six-cylinder, double-acting, two-stroke diesel engine of 6000 I.H.P. The launching of another vessel, the "Vretahom," of 7300 tons deadweight, has taken place recently. This vessel has an eight-cylinder, single-acting, two-stroke diesel engine, which develops 6400 I.H.P. The Swedish shipbuilding industry uses between 80,000 and 100,000 tons of steel per annum, of which only 15,000 tons is manufactured in Sweden. It is anticipated that 55,000 tons of steel will be imported from Germany for the shipyards during the current year. The hot-rolled steel used in shipbuilding was made subject to sequestration in Sweden in 1943, but it is thought that shipyards will get an adequate supply.

The Pig Iron Market

The situation generally in the British pig iron industry must be regarded as satisfactory. Coincident with some falling-off in demand there has been a considerable increase in production, with the result that with the exception of hematite pig iron the various descriptions are in good supply and the output is adequate to meet the big demand. The light castings makers have been hard hit by the war and in the majority of cases are not well occupied. There is, however, plenty of high-phosphorus pig iron available, much more, in fact, than the light castings industry requires. Many foundries, both in the light castings industry and in the heavy engineering departments, as well as jobbing foundries, are only buying their pig iron for forward delivery in limited quantities. The jobbing foundries that are really busy are chiefly amongst those who are engaged upon the production of special products or who are catering for the machine tool industry. Lately, a number of engineering foundries have found that Government requirements have lessened, and in some cases orders they held have been cancelled. This branch of the consuming trade, however, is still using considerable quantities of low and medium-phosphorus pig iron. The situation, however, has changed for the better since a few months ago this iron was in tight supply. Consumers are now able to obtain as much as they need, provided they hold the necessary licences. In the hematite department the position does not seem to have altered much since the early part of the year. It is known that production has been increased, but the demand appears to have kept pace with the larger output, and the Iron and Steel Control exercises great care in allocating this description. It is expected that the production of hematite will be further increased when larger supplies of high-grade ore reach this country from North Africa, but this depends largely upon the shipping position, which for the time being does not seem very favourable. The increased production of medium and low-phosphorus iron and refined iron has to some extent reacted upon the demand for hematite, since consumers of the latter are using these irons in considerable tonnages as a substitute. The volume of business in refined pig iron has declined during the past few weeks and in many cases producers would be glad to obtain more business. This is the direct opposite to the condition which ruled in the earlier part of the year. The production of basic pig iron is maintained at a high level and the steel works are obtaining their full requirements. At one time some concern was expressed by consumers at the possibility of a stringency developing in this department, but fears of that sort have now entirely vanished.

Scotland and the North

The Scottish iron and steel industry is experiencing heavy pressure from consumers and, without exception, the works are endeavouring to clear as many of the contracts on their hands as possible before the end of the year. The plate position has not materially changed, since the demand from the shipyards, which have priority, is still absorbing large tonnages, whilst the heavy engineers, marine engineers, and power plant makers in Scotland are also big consumers. It is evident that the producing works will carry over a considerable tonnage of orders for plates into the next delivery period and, in fact, the works for the most part seem to be booked up for several months. The sheet industry, which is assisting by producing quantities of light plates, is also fully occupied for a long time. The shipyards are taking large tonnages of sheets and consumers having fresh business to place have difficulty in finding a works able to give delivery in reasonable time. The heavy demand for small sections, which is keeping the re-rolling works fully employed, is also largely due to the big demand from the shipbuilders, who, in addition to the re-rollers, have a big tonnage of orders in hand for small steel bars. Their requirements of semis, however, are being fully met from British works, and this has enabled the Iron and Steel Control to conserve the stocks of imported semis now in this country. The demand for iron bars has also improved. To some extent this is due to users of steel bars taking iron bars instead, owing to the more favourable delivery terms they are able to obtain. The iron and steel consuming trades in the Lancashire district are almost entirely employed on Government work, and important tonnages of steel are steadily passing into consumption. There is an active demand for all kinds of plates, but recently locomotive builders have been taking fair quantities. For some time past there has been a steady call for steel bars and deliveries have been on a heavy scale. An active business has passed recently in shafting bars. Colliery managements are pressing to obtain big quantities of steel for maintenance, and there has been a strong demand recently for props and arches. Pressure for alloy steel has subsided somewhat, but there is still an important trade passing in alloy steel for the aircraft and armament manufacturers. The steel works on the North-West Coast are fully employed and have a heavy weight of orders in hand. The producing works, however, are maintaining regular deliveries to consumers.

The North-East Coast and Yorkshire

Production of iron and steel by the works on the North-East Coast is at a high level and is almost entirely on Government account. Deliveries have been maintained with regularity and pressure from consumers has been heavy. Although the works are pressing to complete contracts on hand before the end of the year, it is probable that there will be a fair tonnage of uncompleted orders. Changes in the Government war production programme have affected production only slightly in the aggregate, since the industry has been organised to permit a certain amount of elasticity in production to meet these changes. There is a strong demand for alloy steels, which are required in big tonnages by the aircraft and armaments makers. The volume of business passing in these kinds of steel is less than it was a few months ago, and the producers seem well able to take care of consumers' requirements. The call for plates has not materially changed. The demand from the shipyards is still sufficient to absorb the larger proportion of the output and, in addition, the needs of heavy engineers, wagon builders, and locomotive builders represent a big tonnage. The increase in the production of semis which took place some weeks ago has been maintained and the re-rollers are getting regular and satisfactory deliveries; in fact, in some cases re-rolling works have been able to build up fairly substantial stocks of defective billets, props, &c., although there is not such a large outlet for sheet bar crops and defectives as was the case only a short time ago. The demand for structural steel is steady, but there has been no large volume of business passing in heavy sizes. There is considerable activity, however, in light structural steel, small rounds, and small steel bars, and the re-rollers also are producing big tonnages of these descriptions. The Yorkshire steel industry is in full operation and the works are carrying sufficient orders on their books to keep them busy for several months. The basic steel works are responsible for a big output, whilst most of the plants engaged in making acid carbon steel are fully employed. An active business is passing in the more expensive kinds of alloy steel, and there is a brisk request for the alloy steel used by the engineering works. All the finishing branches of the steel industry are fully employed and there is an active business passing in strip and steel bars.

The Midlands and South Wales

The iron and steel industry in the Midlands is operating practically at capacity. Such changes as have occurred have been in certain departments in which the Government demand for particular products has declined; but, generally speaking, this has been made up by a stronger request for other descriptions of steel. The works are assured of full operations until the end of the year, and it is expected that there will be a heavy carry-over into 1944. The larger part of the output is for priority consumers and deliveries have been well maintained by the steel makers. The demand for plates is still an outstanding feature of the position and all the producing works are fully taxed to meet consumers' requirements. Recently the production has been stepped up. Boiler plates have been in particularly heavy request and large orders have been placed by locomotive builders and power plant producers. There is also a strong request for plates from the heavy engineering establishments and from wagon builders. The steel works making the lighter descriptions of sections and the re-rollers are employed practically at capacity and large tonnages of this material have passed to the shipyards. Considerable tonnages of sheets also are being taken up by the shipbuilders, and important outputs are being made of heavy and light sheets. There has not been much change in the galvanised sheet department, as these are only made to special authorisation, but recently an important volume of business has been transacted in painted sheets. The steel works in South Wales are maintaining a big production, although the demand for certain descriptions has declined as a result of changes in the Government's war production programme. The strong request for plates from the shipbuilding and engineering industries keeps the makers fully employed. While business in sections is considerable, a great part of the demand is for the light descriptions, and only lethargic business is passing in heavy sections. The Welsh works producing billets and sheet bars are making big outputs and large quantities are being sent to consumers in other parts of the country. The tinplate makers in South Wales are limited in their operations by the regulations controlling the manufacture and use of tinplate. The home demand has been rather better of late, but there has been no improvement in export business.

Iron and Steel Scrap

Conditions in the iron and steel scrap market have not altered a great deal, but during the past week or two more business has been moving, largely because consumers have been accepting heavier deliveries of the lighter and more inferior qualities, whilst the better and heavier descriptions are in somewhat tight supply. Suppliers report also that truck labels are being issued with more freedom. There is an urgent request for good heavy mild steel scrap cut to furnace and foundry sizes, and some consumers are hard pressed for supplies. The difficulty of obtaining adequate quantities of this scrap has resulted in a stronger demand for bundled steel scrap and hydraulically compressed steel shearings. Although good quantities of mild steel turnings continue to arise, the supply is not so plentiful as even a few weeks ago, and consumers seem somewhat anxious to obtain quantities of the good heavy and chipped grades. A more active business has passed recently in mixed wrought iron and steel scrap for basic steel furnaces, and the supply of good heavy scrap is rather tighter than recently. Light material is moving more freely and consumers are taking larger deliveries. Compressed basic bundles are finding a ready market and fair supplies seem to be available. Some tightness rules in the cast iron scrap department, and as a result the volume of business in this description has decreased. Consumers are eagerly taking up good heavy cast iron scrap in large pieces and furnace sizes, whilst there is an active business passing in light cast iron and good cast machinery scrap in cupola sizes. Owing to indications of tightness in the supply position, ironfounders are showing a willingness to buy any parcels that come on the market; supplies, however, are evenly distributed. Many consumers appear to be short of their requirements and are eagerly searching the market. Wrought iron scrap is in plentiful supply, the lighter descriptions being available in considerable quantities. Consumers are also buying cast iron borings of all qualities with some freedom.

Notes and Memoranda

Rail and Road

L.M.S. PLEASURE STEAMERS AT WAR.—Thirteen of the L.M.S. Clyde pleasure steamers are engaged on coastal defence work and minesweeping. Three have been lost, the "Mercury" by mine and the "Juno" and "Kylemore" by air attack. The "Caledonia" has an enemy aeroplane to her credit, while the "Queen Empress" has brought down two.

ROAD BUILDING IN ALBERTA.—Alberta's Minister of Public Works, Hon. W. A. Fallow, recently stated that road expansion during the last twelve months had been the greatest in the history of the province. In spite of necessary restrictions placed upon materials, 2000 miles of roads had been graded and 650 miles of municipal and district roads had been gravelled.

JAPAN BUILDING ROAD AND RAIL.—According to Japanese radio, a highway is to be constructed to connect the northern and southern portions of Celebes. The first section will link Mangkoeana, on the Gulf of Boni, with Majoa, near Lake Posso, on the Gulf of Gorontalo. Alongside this is the construction of the overland railway of Celebes Island, which is reported to be progressing. Meantime, reports are coming through that the Japanese are doing all they can to improve their transport facilities in south-west China, Burma, Siam, Indo-China, and Malaya. Burma, now ranked as an independent state, has been presented by the Occupying Power with the Burma State Railways, hitherto regarded as British owned.

ANOTHER L.N.E.R. LOCOMOTIVE CONVERSION.—One of the six 4–6–0 class "B 3" locomotives of the L.N.E.R., originally built by the former Great Central Railway during 1917–20 with four cylinders and piston valves actuated by Stephenson link motion, recently fractured its cylinders. The opportunity was therefore taken to rebuild the engine with two cylinders exactly similar to those used on the class "B 1" mixed traffic 4–6–0 locomotives and with the "B 1" type of boiler, thereby eliminating cylinders and boiler of non-standard design. The engine thus converted is "No. 6166," originally named "Earl Haig." Along with "No. 6168," "Lord Stuart of Wortley," of the same class, she was fitted with Caprotti valve gear in 1929 and reclassified "B 3/2."

"SCALING" OF CONCRETE PAVEMENT.—To reduce scaling on the surface of new concrete paving, the Ohio State Highway Department has developed a method of spraying newly laid pavement with an emulsion of linseed oil. To apply the linseed oil, water and kerosene are added at the rate of one part of oil to an equal volume of kerosene and eight parts of water, plus the addition of ¼ lb. of soap powder for every gallon of linseed oil. The resulting emulsion is applied by a standard bituminous pressure distributor at the rate of 0·1 gallon per square yard. In warm weather the water evaporates in about one hour to leave the surface of the pavement coated with a film of oil. The purpose of adding the water is to increase the total volume of liquid applied, so that it can be applied by a distributor.

Air and Water

BRITISH COLUMBIA PLANS A NEW BRIDGE.—Proposals are afoot for the construction of a new railway bridge across the Fraser River in British Columbia, to replace the existing forty-year-old low-level swing span structure. Engineers' estimates place the cost of substituting the swing span with a vertical lift span at approximately 1,000,000 dollars, while construction of a new bridge would range from 2,000,000 to 3,000,000 dollars. In the event of a new bridge being built, it is possible that a new site further upstream would be selected.

CANADA SLACKENS SHIPYARD PACE.—According to advices, British Columbia is easing off ship production, and the reorganisation of labour in some Vancouver shipyards is under way. Men are being transferred to meet the man-power shortage and provide labour for work of a higher priority than cargo ship construction. Women are still to be employed in the yards, but the number to be added to the lists will have to be decided when the present situation is cleared up. One shipyard manager has stated that launching times for cargo ships, which used to take the water sixty days after the keels were laid, has been extended to eighty days.

ABANDONING A TUNNEL.—The readiness with which Americans and Canadians abandon an undertaking that has served its purpose is shown in the case of Esker tunnel, part of the Steep Rock Lake diversion project. It cost 120,000 dollars, but it has fulfilled its purposes in the 12 million dollar iron ore development plan, and is of no further use. It was part of the scheme for diverting waters of Finlayson Lake into new channels and opening the way for draining Steep Rock Lake. Meantime the Highway Department of Ontario is considering another project for a highway from Fort William to the Steep Rock iron mines. This stretch of approximately 100 miles has been estimated to cost some 8 million dollars.

INDIAN HYDRO-ELECTRIC SCHEME.—It is expected that after the war work will begin on a new hydro-electric scheme on the border of Madras and Orissa to serve both provinces. A note in Bulletin No. 39 of the Central Board of Irrigation shows that preliminary investigations and surveys with regard to this scheme are being carried out. Preliminary estimates indicate that it is likely to cost Rs. 2,25,00,000. The survey and preparatory designs are expected to be finished this year and will be kept ready for execution as soon as the war is over. Another note in the Bulletin concerns a proposal to increase the storage capacity of the Mukurti reservoir in the Pykara hydro-electric system in Madras by installing four "sinking" type gates in the spillway located in the body of the dam.

DEATH OF A BRIDGE BUILDER.—Major L. R. Z. Wilson, widely known as a bridge and structural engineer, has died in Sydney, Australia, at the age of fifty-four years. His greatest achievement was the building of the Montreal Harbour bridge, which brought him world renown as an engineer. Following graduation from the University of Toronto, Major Wilson joined the Dominion Bridge Company as an engineer. Shortly after the outbreak of the first Great War he enlisted with the Canadian Overseas Railway Construction Corps. Returning to Canada after the war, Major Wilson resumed work with the Dominion Bridge Company, and later was appointed its vice-president. In 1935 a group of business men from Australia invited him to undertake the construction of the Brisbane Harbour bridge, and since its completion he had made his home in Australia.

Miscellanea

SCIENTIFIC BROADCASTS.—On Tuesday, December 14th, a deputation of scientists, headed by Sir Richard Gregory, President of the British Association, met Mr. Robert Foot, the Director-General of the B.B.C., to ask for better and more frequent scientific broadcasts.

THE TELECOMMUNICATION INDUSTRY.—The Telecommunication Engineering and Manufacturing Association has been formed to promote the interests of the industry, to maintain the highest possible standard of telecommunication equipment, and to facilitate, whenever required, collaboration with Government Departments on matters of national concern. The new Association, without overlapping the activities of any of its older colleagues, will, it is believed, fill a gap which has been until now rather conspicuous in the general organisation of our national industrial and manufacturing framework. The offices of the Association are at Aldine House, 10–13, Bedford Street, Strand, W.C.2.

SUGAR TECHNOLOGY RESEARCH.—The setting up of pilot plants to produce food yeast, butyl alcohol, acetone, glucose, and cane wax has been recommended by the Advisory Board of the Imperial Institute of Sugar Technology, which met recently in Cawnpore, and reviewed the work of the Institute during the past year. The Institute has done research on the production of glucose, food yeast, butyl alcohol, acetone, activated carbon, cane wax, refined sulphur, and power alcohol, besides giving technical assistance to sugar factories and to the Government on matters relating to the sugar industry. The Board also approved a research programme which includes the making of cellulose and plastics from bagasse, of filter aids from pressmud, and of potash, citric acid, and lactic acid from molasses.

Personal and Business

MR. LEONARD MORITZ has been appointed a director of British Timken, Ltd.

SIR FELIX POLE has been appointed a director of the Tilbury Contracting and Dredging Company, Ltd.

THE board of the Fairey Aviation Company has invited Sir Clive Baillieu to act as chairman of the company during the absence abroad on official duties of Sir Richard Fairey. At the request of the Minister of Aircraft Production, Sir Clive Baillieu has accepted this invitation.

MR. J. S. BUCHANAN, C.B.E., has been appointed Assistant Chief Executive at the Ministry of Aircraft Production.

MR. W. N. INGRAM has been appointed Deputy Regional Controller of Factory and Storage Premises for the North Midland Region.

COMPOUND ELECTRO METALS, Ltd., inform us that they have now resumed occupation of their West End offices at 42, Pall Mall, S.W.1.

MR. T. L. HALE, vice-chairman of Hale and Hale (Tipton), Ltd., has retired from the board on account of ill-health. Mr. R. C. Leppington becomes vice-chairman and Mr. F. Coe and Mr. J. A. Wylde have been appointed directors.

ADAMSON-HORSEHAY ASSOCIATED, Ltd., has been formed to combine the interests of Joseph Adamson and Co., Ltd., and the Horsehay Company, Ltd., of Wellington, Salop, in the manufacture of mechanically operated structures of all types, including turntables, dock cranes, mechanically operated bridges, strippers, chargers, &c.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association for Scientific Photography

Saturday, Dec. 18th.—Royal Photographic Society, 16, Princes Gate, S.W.7. Display of scientific photographic apparatus. 2.30 p.m.

Institution of Electrical Engineers

Tuesday, Dec. 21st.—S. MIDLAND CENTRE: Watt Memorial Institute, Great Charles Street, Birmingham. "Enemy Air-Borne Radio Equipment," C. P. Edwards. 6 p.m.

Institution of Engineers-in-Charge

Saturday, Dec. 18th.—St. Bride Institute, Fleet Street, E.C.4. "X-Ray Equipment," W. R. Gray. 2.30 p.m.

Institution of Mechanical Engineers

To-day, Dec. 17th.—Storey's Gate, Westminster, S.W.1. Symposium of papers on Inspection, Cost, and Quality Control. 5.30 p.m.

Saturday, Dec. 18th.—SOUTHERN BRANCH: Kimbell's Restaurant, Osborne Road, Southsea. "A Survey of Plastics from the Viewpoint of the Mechanical Engineer," S. Livingston Smith, and "Moulding Plant for Plastics," J. L. Daniels. 2 p.m.—YORKSHIRE BRANCH: Chemical Lecture Theatre, The University, Leeds. "Gyroscopic Principles and Applications," C. E. Inglis. 2.30 p.m.

Tuesday, Dec. 21st.—E. MIDLANDS BRANCH: The College, Loughborough. "Gyroscopic Principles and Applications," C. E. Inglis. 7 p.m.

Friday, Dec. 31st.—Storey's Gate, Westminster, S.W.1. "Paints and Protective Finishes for Metals," A. J. Philpot. 5.30 p.m.

Institution of Production Engineers

To-day, Dec. 17th.—LINCOLN SECTION: Technical College, Lincoln. "Modern Machine Tool Manufacture," T. P. N. Burness. 6.30 p.m.—EASTERN COUNTIES SECTION: Lecture Hall, Museum Street, Ipswich. "Output and Environment," K. G. Fenelon. 7 p.m.

Junior Institution of Engineers

To-day, Dec. 17th.—SHEFFIELD SECTION: Metallurgical Club, West Street, Sheffield. "Petrol Engines," H. E. Cooper, and films. 6.30 p.m.

Saturday, Dec. 18th.—39, Victoria Street, S.W.1. Presidential Address, Sir Maurice Denny. 2.30 p.m.

Manchester Statistical Society

Saturday, Dec. 18th.—College of Technology, Sackville Street, Manchester. "Group Control Charts," J. R. Womersley. 3 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Dec. 17th.—STUDENT SECTION: Mining Institute, Newcastle-upon-Tyne. "Electrical Power in a Steel Works," R. J. Fothergill. 6.45 p.m.

Monday, Dec. 20th.—Mining Institute, Newcastle-upon-Tyne. "Some Considerations in the Application of Light Alloys to Ship Construction," W. Muckle. 6 p.m.

Royal Institution

Tuesday, Dec. 28th.—21, Albemarle Street, W.1. "Vibrations and Waves," E. N. da C. Andrade. 2.30 p.m.